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LECTURES.

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Captain M. S. NOLLOTH, R.N., in the Chair.

MILITARY DRAWING.*

By Lt.-Col. H. GARNET MAN (late Royal Military College).

It does not appear that the ancients were acquainted with the use and advantage of maps up to the time of Anaximander, or about two thousand two hundred years since; and Ptolemy, who flourished in the first century of the Christian era, was the first who used meridians and parallels of latitude. The early maps were chiefly compiled from the itineraries of the Roman and other armies; and we are much indebted to the army and navy of different civilised nations in every period for the materials from which maps have been constructed.

The art of exhibiting the irregular surface of the earth upon these maps when their scale will admit of it, is of very modern date, and upon it hinges, in a great degree, the tactics of modern war.

A General now possesses an immense advantage over the heroes of antiquity from the facilities of gaining a picture of the country which is the theatre of war, or any part of it that may be necessary, upon the spur of the moment; these pictures are drawn by persons appointed for the express purpose, and, indeed, it were useless to insist upon the utility of an art now becoming more generally known and of such acknowledged importance.

* I have, in this Paper, made large extracts from a work published many years ago by Mr. Buor, Professor of Military Drawing at the Royal Military College; a work I consider to be one of the best on this subject.—G. MAN.

But there are many others to whom the art, in all its variety, is of equal importance in their several capacities; to civil engineers, geologists, gentlemen of landed property, and others, for conveying information generally of the natural face of a country. These are the advantages of modern over the ancient maps, which, besides their rudeness and inaccuracy, were only lineal, or consisting of roads, rivers, boundaries, &c.

It is curious and interesting to observe how, from the rudest beginning, the moderns have raised the art of representing ground, a word commonly used to express that part of a map or plan which is shaded so as to give an idea of the hills. The little elevated molehills which anciently, and even a few years since, and still in some few instances, fill up the spaces between the rivers on maps, have, by degrees, been blended together and formed into regular chains of heights, their magnitude and steepness being estimated by the breadth and intensity of their shade; and the geographer has borrowed from time to time ideas from the military draughtsman, until the irregular face of a country is now given in a general manner, more agreeably to its natural aspect than it was formerly. Hitherto, however, this improvement in maps, although of such general advantage, has been chiefly confined to those intended for military purposes. The establishment at the Tower of London was the first of its kind, and many plans upon these principles were there collected; in some, as old as the beginning of the last century, a great variety of styles and traces of an enlarged understanding of the subject might be seen, according to the merit of the individuals by whom they were drawn; many attempts to imitate nature as seen from a point above, or according to the orthographical projection, reflect great credit upon their authors, considering the low state of water-colour drawing in this country at the time they were drawn. On the continent great importance has ever been attached to this kind of drawing; but, until within a few years, the Tower establishment and the Royal Military Academy at Woolwich contained almost exclusively the only persons who in this country were qualified for such an undertaking.

The Ordnance Survey of Great Britain and Ireland, which is perhaps the best ever undertaken, with its adjuncts under Colonel Colby, opened a grand field for the acquirement of topographical knowledge; and the Royal Military College at Sandhurst has become a school in which such knowledge has been much cultivated. From these sources, as might be expected, the British Army is now well provided with persons who possess the necessary talent for supplying it with the most interesting documents of the kind that can be desired; and to make this species of drawing more generally known in every line of life where it can be useful, is a great desideratum.

Military Sketches.

Despatch and simplicity of execution are the great things to be aimed at in a military sketch, and, although the greatest possible accuracy may not be absolutely necessary, yet this want of it should not become a cloak for glaring errors, for it must be remembered that these sketches are often the most authentic sources of information we possess as to the topography of distant countries; if they are thus defective, there is only one thing in their favour, namely, that when still further reduced into geographical maps the errors are considerably diminished. The errors to which we at present

allude are, first, the general outline being incorrect, because distant points have not been fixed from lines of sufficient length, or by using very imperfect instruments; secondly, that the hills or mountains, not being drawn with a proper regard to their real form or steepness, cannot be properly connected when the separate portions of a large work are to be blended together in one general map.

It may be convenient to separate military sketches into two divisions: first, the rapid sketch of a position in advance, or of a battle immediately after it is fought, to be sent with the despatches; or of a line of route, &c.; these may be done secretly, with but little assistance from instruments, sometimes without any, and, as they are to serve only a transient purpose, much latitude must be allowed to those who perform such service. Secondly, such sketches, or rather surveys, as may be undertaken by officers at periods of greater leisure, yet not admitting of a numerous party, with elaborate instruments, being employed upon them, and also frequently requiring some degree of secrecy.

From the first division of military sketches we cannot expect much when they have served their original purpose; their imperfect execution excludes the further use of them when anything better can be found. It is to the *second* division that the most importance will always be attached; it is a collection of these that will ever be considered valuable in a military and geographical, perhaps we may say also a geological, point of view, and therefore the errors before mentioned should be avoided as much as possible.

The principles of military sketching cannot differ essentially from those of surveying. They both consist in determining the sides and angles of real or imaginary figures upon the surface of the earth. These are always resolvable into triangles, by means of which we lay down these figures upon paper to any required scale. But the practice differs very considerably; and it is for this reason that they are called *sketches* rather than surveys, because so much of them is usually done by the eye, instead of being a continued series of angles and measured lines, as in the more elaborate surveys.

As, in surveying large tracts of country, large triangles must be first formed with great care, to find the true relative situation of distant objects, and these again subdivided into smaller ones, until there is no longer any fear of the errors of mere surveying accumulating too far before they are checked by reference to those points, so in military sketching, when a tract of country is to be drawn, containing one hundred square miles or more, a similar proceeding cannot be safely dispensed with, for nothing can ensure a proper degree of accuracy but a triangulation of some kind.

It cannot, therefore, be too strongly recommended to persons employed on this service to pay great attention to these points. It may not be improper to mention in this place, that it is usual to consider all military plans whatever, as made up of two component parts, one of which is called ground, and comprehends the variety of surface only; the other, called detail, embraces roads, rivers, cities, towns, villages, marshes, woods, fords, bridges, and every other minutiæ, the existence of which can be essential in a military point of view.

We have adhered to this distinction in this place, although not in surveying, because it is the practice in some cases to express by certain characters the various objects constituting the details of a plan, and where no time can be spared for drawing them as they really are; while in surveys, every house or cluster of houses, &c., will always be drawn as they happen to stand; every road with hedge or other fence will be shown by two lines, and when passing over a common or otherwise, and not bounded by fences, it will be shown by two dotted lines, the line always showing a defined boundary, and the dotted line one that is not defined; whereas, in military sketches, a few houses, without reference to their precise disposition or a single spot, denotes a village; a single line will be a bye-road; a double line, a post road; a dotted line, a footpath; a circle with small teeth, a water mill; and so on. We shall not discuss the advantage of retaining these characters, as a four-inch scale is abundantly sufficient for every important object to be drawn as it is in nature, except being somewhat larger; but in geographical maps, or any others on a small scale, which preclude the possibility of doing without them, or in very hasty sketches, they are certainly indispensable.

Many instruments have been contrived for military sketching, each of which has some advantage peculiar to itself, but the only ones we shall mention are, the surveying compass, Sir H. Douglas's reflecting semicircle, the pocket sextant, and the plane-table. To these must be added a case of leather to hold the sketches, and an ivory protractor to lay down the angles which are taken by the compass, and also the distances; these are contained in the sketching case, with a pencil. The sketches are drawn upon paper or ass's skin: the latter has perhaps some advantage over paper from its not imbibing the moisture of the atmosphere, and therefore preserving greater uniformity in the strength of the black-lead pencil; still as no two pencils are exactly alike in texture, when one is exhausted another may not match the work done by the first, and the difference is not greater than what arises from the unequal degree of moisture imbibed by paper in different states of the atmosphere. The skin is also very expensive; hence, when the sketch is transferred to paper, it is rubbed out to make room for another, and the original sketch is then lost altogether. Upon the whole, and considering the advantage of preserving original sketches, paper mounted upon cloth should be preferred when these instruments are used.

One of the most essential things to be acquired is that of judging distances with accuracy. Upon this everything depends in a hasty sketch, where instruments are sparingly used, or excluded altogether. It is commonly acquired thus: the value of the pace is previously ascertained upon a measured distance—a long distance is best, as the mean value of a pace can be established upon it with greater exactness than on a small one; a distance is then judged, and afterwards paced, the difference is noted, and the practice continued, until the student is competent to trust himself in judging distances of considerable length. He is now capable of sketching by this method, transferring the principles and artifices of surveying into it as completely as the exclusion or absolute want of instruments will admit; that is to say, judging, or, if he please, pacing his distances, and operating exactly as he would do were they measured, and his angles also.

Before quitting this subject, it may be right to mention that, in this rapid sketching, Sir H. Douglas's semi-circle is perhaps the best instrument to be used, if an instrument be allowed, because it will determine the places of houses, &c. with great despatch and correctness, thus leaving very little to be done by judging or pacing distances; for a large piece may be rapidly sketched even on horseback, if a single distance is first assumed as a base, and from it several objects fixed, which leaves nothing more to be done than filling in the sketch by the eye; but the circumstances under which military operations are performed are so extremely varied, that an officer must be left to judge for himself upon the necessity for using or rejecting instruments according to them. When a person has been regularly taught to make correct plans by any of the methods I have mentioned, he will find, that barely riding over ground, and examining it with the eye of a military man, will be sufficient for him to describe it roughly upon paper, and that such a sketch as he can produce by this means, especially if aided by a few angles and notes that take little time to obtain, will communicate a very competent knowledge of the ground to any other officer, for whose use it may be required. It is a practice with many persons to obtain, if possible, provincial maps, and lay down the ground upon enlarged outlines from them; but, unless these maps are good, we doubt whether much is gained by this proceeding; for equal error will arise by hastily enlarging a bad map, as in trusting to the eye occasionally corrected by a few angles, nor can such maps always be had; indeed, any plan enlarged, unless it be of triangles or buildings, which have the dimensions actually written in their proper place, will always be a failure.

It will be in vain to expect that pacing and taking bearings by a compass through a winding road of great extent can possibly be true; it may be barely trusted to for short distances and straight roads, but not otherwise, for the angles are often uncertain, and so are the paced distances in many cases; we must therefore devise a method which will obviate these objections, and, while it ensures general accuracy, throws all the errors upon those parts which are of the least importance. We begin by measuring, or at least pacing, a base as long as possible, if paced, it should be gone over two or three times, and the mean of them taken for the true length. There are often great difficulties in selecting a spot favourable for this purpose; it most commonly happens that when a spot has been found, it lies so inconveniently as to make the intersection of distant objects from each end too acute to be trusted to.

Now, from points thus fixed with much care, other objects may be determined, always, if possible, in the larger triangles, having three lines passing through the same points, and the work will be more correct than when we determine too many from the original base, a practice much to be avoided, for the errors occasioned by so many acute intersections at the commencement, if they are not checked properly from one another, or others better situated for that purpose, will infallibly derange the whole work. It must be laid down as a principle that the most conspicuous objects are to be most correctly placed, and the minor points derived from them; by this means we command the greatest possible accuracy, and throw all the errors upon those parts where they can be propagated no further.

It is a good method to take as many angles as possible at each station, and make our selection of the greater triangles afterwards, unless, from a previous knowledge of the country, that has been already arranged; and it will generally happen that we can see the interior of a triangle from at least two of the sides which inclose it; if not, the points therein must be fixed from any other side of any adjoining triangle where they can be seen, as each side of a great triangle becomes a base for fixing interior points. The triangles are generally laid down by a protractor in military sketches, but, as we suppose in this division that time and instruments are allowed, and as we can produce a sketch little short of a real survey in point of accuracy, we have no hesitation in recommending that those triangles which may have sides of one or two feet in length upon paper, or from three to six miles in length upon the four-inch scale, should be calculated and laid down by the length of the sides themselves. This is my own practice, because I know that when these lines exceed eighteen inches, let the scale be what it may, they will become very liable to error if continued too far by a protractor, and hence, if only a few of the greater triangles are calculated, and so laid down, we are assured of their accuracy, and also of the interior points when laid down by a protractor. The method about to be described depends so much upon the correctness of the triangles, that they must be managed with the most scrupulous attention.

The instruments chosen for finishing the sketch after the triangulation is finished, will be either the plane-table, or the sketching case and skins, aided by the surveying compass; for the triangles themselves may be formed by the sextant or theodolite at the option of the person employed.

Of the first-mentioned instrument, which is far the best for expedition and accuracy, we need say but little here. What remains is common to it and the sketching case, only with the difference arising from the method of mere sketching, as it respects the plane-table, and laying down the work when we use the sketching case and skins. Having determined as many points as may be deemed necessary, some of which should fall without the limits of the sketch, and will be productive of great advantage while sketching near its boundaries, as well as when joining it to others,—we must dot them down from the paper they have been constructed upon to the skin we propose to use, and mark their names. Now we go to one of those points and take the bearing of some other, the more distant the better, and, connecting the two points in question, we, by means of this bearing, lay down a line representing the magnetic meridian of that particular compass employed, for they generally differ a little in different instruments as before noted, and also many others at about an inch apart; we are now in condition to begin our sketch in the manner following:

Before we quit the place, if any ground, road, or other object necessary to be noticed, is either there or near it, we draw it on the spot, and then, always keeping upon the highest ground, find our place by taking the bearing of any two or three objects forming the points of our triangles, and laying down those bearings from the objects towards ourselves. We thus ascertain our place correctly if these lines meet, as they will when good instruments and care are used. This practice is common to this method, and that by the plane-table, but the latter instrument does it more quickly and more correctly, being less liable to error than

laying down bearings by a protractor when taken by a compass, thus including the error of both these instruments. The place being found, we proceed as before to draw the contour of the ground, &c., and, supposing a road, house, stream, &c., to be near, we take a bearing to some point upon it, and, pacing the distance, examine the object and mark this point, sometimes taking also a bearing both ways from that place, in the case of streams or roads, and drawing either, as far as we can trust ourselves, while upon the spot. Again, finding our place upon some adjoining feature or height, and doing the same, we join it to what was last done by the eye, occasionally assisted by the instruments; and, by continually keeping upon the high ground, where we can see fixed points within a mile or two, we find our places; and from the places thus determined other points in roads, &c., are found, and the intermediate bends drawn by the eye on the spot; thus ensuring general and also particular accuracy if we please, by a continual subdivision of errors; we also avoid the fatigue and inaccuracy of pacing over unfavourable ground, and save much time by not actually going through the roads as in surveying. But many other things are done as we go on: for example, at the places thus constantly found we intersect houses and other objects, but particularly houses, because they are always upon or near a road, and therefore determine a point of some value in drawing in those roads; and in passing by woods or commons, we always do as much of their boundaries as we can see from that particular spot; and also, if in passing, we are in line with any boundary of considerable length, and nearly straight, although at a mile or more distance, we find our place and take a bearing in the direction of its length, and thus prepare the distant parts of our sketch before we actually come to work upon them. The difference between sketching and surveying, which was said to be exactly reversed, will now be evident, for, in the former we derive the roads, &c. from the hills; while in the latter the hills are derived from the roads, &c. The military officer has more to do with the hills than the roads; if the latter are not perfectly true as to their flexure, so that the former are well connected and expressed, the plan will lose nothing in the estimation of the general, who should, nevertheless, know exactly the state of the roads with respect to breadth and goodness, and the streams as to practicability in fording, their bridges, mills, &c., but the ground is indispensable, and so are the general dimensions of wastes or places fit for encampments, as well as woods and the nature of their trees, whether timber, of what kind, what underwood, and in inclosed countries, the nature of the timber in the hedges, &c.; but these things more properly belong to the written reports that should in all cases accompany plans made for military or political purposes. We must now observe that there will sometimes occur cases in which, from a paucity of points, or when, from being entangled in small ravines or otherwise, many of them will disappear, we are obliged to have recourse to pacing, no other method being practicable; but this does not invalidate the system; for filling in small intervening spaces becomes at length so familiar to practised persons as to present no great difficulty in any case whatever. To avoid this inconvenience, we always sketch around the difficult places, and by invariably diminishing the space, circumstances will always enable us to fill it in by mere reconnoitring; and besides, we constantly determine by intersection, the places of many objects in the parts that appear likely

to produce this difficulty, and thus often avoid it altogether. There is also another case, namely, a flat inclosed country, where we must pace and take bearings, unless we can regularly survey it, for it is obviously impossible to fix points, or find places if they were fixed; but this will not often happen; and with respect to extensive forests, it is well known and universally acknowledged, that there is no other way of sketching a country so circumstanced than by examining its parts at such convenient distances as may present themselves, and sketching the mountains by studying the nature of the ground, and its analogy with surrounding features, or those we have seen similar in other countries.

It is evident that much must be done by the eye alone in military sketching. The greatest advantage is to be derived from the accurate use of that organ; and whenever it saves an instrumental operation we must by no means neglect it. The nature of roads may, in great measure, be inferred from the surrounding soil, for, whatever may be its component parts, they will influence the state of the roads materially, which, for the most part, are composed of materials near at hand; this is one advantage of knowing, from the configuration of hills and mountains, their probable, we may almost say certain, composition. But, that nothing may be left to conjecture in a case of such importance as the march and subsistence of armies, this subject should always be included in the written report.

Wednesday, 17th April, 1861.

Major-General the Hon. J. LINDSAY, M.P., in the Chair.

ROTATORY STORMS.

By Captain Sir FRED. W. E. NICOLSON, Bart. R.N., C.B.

THIS Lecture was originally delivered at a meeting of the Literary and Scientific Society of Shanghae, and contains, in consequence, more elementary matter, and a greater number of local illustrations, than would have been considered necessary, had it been prepared in the first instance for the Lecture Theatre of the ROYAL UNITED SERVICE INSTITUTION. To persons unacquainted with the subject, it may be proper to state that most of the diagrams are copied from various well-known works on meteorology.

1. That branch of meteorology to which the law of storms belongs has been developed only during the last thirty years. Previous to the researches of Redfield, Reid, Dové, and others, all winds were supposed to blow in straight lines. The facts recorded by these observers induce the belief that all violent storms, and probably many, if not all, the variable winds, rotate in obedience to certain laws. Storms are known under various names in different parts of the world. In the West Indies they are termed "hurricanes;" in the Chinese seas, "tyfoons;" and a new name, "cyclone," indicating their revolving character, is coming into general use.

I shall use these names indiscriminately in this paper.

2. Colonel Capper of the East India Company's Service was one of the first, if not the very first, to draw attention to the peculiarities of the great storms in the Indian Ocean. He published a work on winds and monsoons in 1801, in which he suggests the possibility of ascertaining the position of a ship in a whirlwind by noting the strength and changes of the wind.

3. This suggestion of Colonel Capper's does not appear to have excited much attention, nor was any progress made in elucidating the phenomena of storms until the subject was taken up by Mr. Redfield of New York. His investigations commenced in 1821; but his records of storms were not published until they appeared in the American Journal of Science for 1831. Mr. Redfield was the first to explain the oscillations of the barometer as connected with the veering of the wind, a phenomenon which had perplexed the ablest philosophers since the invention of that instrument by Torricelli.

4. Sir William Reid, following in the footsteps of Mr. Redfield, has contributed several works to this branch of meteorology. We must all deplore the loss which both services have sustained by his death. He was a most kind-hearted, simple-minded man, and ever ready to impart to others the knowledge he had acquired during a long and laborious life

spent in the public service. Sir William was employed at Barbadoes in restoring the Government buildings destroyed in the hurricane of 1831; when 1477 persons lost their lives in the course of a few hours. This sad catastrophe directed his attention to the investigation of the West Indian hurricanes, and brought Mr. Redfield's recently published paper under his notice. Feeling convinced of the correctness of the views expressed in that publication, Sir William sought to verify the theory thus propounded, and forthwith collected data from every quarter. He has published the results of his investigations in two separate works, which contain a most valuable collection of facts relating to this branch of meteorological science.

5. Professor Dové of Berlin has been engaged, since 1821, in studying the winds and their phenomena, and has published several excellent memoirs on the subject. He claims to rank with Redfield as the discoverer of the law of storms. His researches, like those of Redfield and Reid, were in the first instance confined to storms in the northern hemisphere. From a consideration of the phenomena observed during these storms, these three meteorologists, although working independently of each other, came to the same conclusion, that gales south of the equator would be found to rotate in the opposite direction to those of the northern hemisphere. More extended observation has fully confirmed this theory, which they simultaneously made public.

6. Professor Espy of the United States is another writer on storms and winds. Although his theory differs from that of Redfield and Reid, it is considered by many that the difference is more apparent than real, and that the *centripetal* winds of Espy's theory will in fact produce the *whirlwind* of the *rotatory* theory. An explanation of the means by which the two theories may be reconciled will be given when we come to treat of the causes by which cyclones are produced.

7. Dr. Thom and Mr. Piddington likewise deserve particular notice; the former has devoted his attention to the storms in the Indian Ocean; both north and south of the equator.

8. Mr. Piddington, who, I regret to say, has recently been taken away in the midst of his useful labours, held an appointment at Calcutta; he has thus been enabled to collect a mass of important data respecting storms in the Indian seas; and he has entitled himself to the gratitude of every seaman for the publication of his "Sailor's Hornbook," an excellent handbook for the mariner in the regions of hurricanes and tyfoons.

9. Sir John Herschel's article on meteorology in the last edition of the Encyclopedia Britannica, and the works published by Admiral Fitzroy's department at the Board of Trade, contain much valuable information respecting storms and their phenomena; and the elaborate list of works on meteorology at the end of Sir John's article will be found most useful to those who wish to study this interesting science in greater detail.

I shall now proceed to explain the law of storms, premising, however, that I shall avoid entering upon the more extensive question of the winds in general, except where I may find it absolutely necessary to illustrate the special subject we are about to consider.

10. The law of storms may be briefly stated as follows:—All strong winds to the *northward* of the equator are whirlwinds, revolving in a direction *opposite* to that of the hands of a watch. See Plate I.

To the *southward* of the equator the rotation is in the *contrary* direction. See Plate II.

11. In addition to this rotatory motion, storms have likewise a progressive movement, which may be thus described:—Taking the West Indian hurricanes as an example for the northern hemisphere, we find that they move in the first instance to the *west-north-west*. Then as they recede from the equator their course becomes more *northerly*, and they gradually recurve to the north-east. Their path thus forms a species of parabolic curve, whose vertex lies near the Gulf of Mexico, in about 30° north latitude. See Plate III.

Storms in the southern hemisphere likewise move in a westerly direction in the first instance, then bend to the southward, and finally recurve to the eastward. See Plate IV. The final direction of those best known, which have been chiefly observed in the neighbourhood of the Mauritius, is about *east-south-east*. Although fewer storms have been accurately observed in the southern than in the northern hemisphere, a sufficient number of storm-tracks have been laid down to prove that their paths are curves of a parabolic form, similar to those north of the equator; and that their vertices are situated in about 20° to 25° of south latitude.

12. The rates of progress in both hemispheres, as ascertained from numerous observations, exhibit most remarkable differences of velocity.

	Miles an hour.
Redfield estimates the rate as - -	9·5 to 43
Thom „ „ - -	2· to 9 or 10
Piddington „ „ - -	2· to 39
Reid „ „ - -	7· to 12

It may not be unworthy of note that the hurricane of 1822, which caused an inundation of the Ganges and Burrampooter, when 50,000 people are said to have perished, is the storm whose rate of progress appears to have been the slowest of those recorded.

13. The diameters of cyclones vary quite as much as their rates of progress. Some are proved to have been only 50 miles in diameter, while others have said to have expanded to diameters of 1,000 miles and even more. These storms of vast circumference have been principally noticed in the North Atlantic. The average diameter of cyclones may be estimated at from 300 to 500 miles.

In the hurricane of November, 1839, which devastated Coringa on the western side of the Bay of Bengal, it was found that the violence of the wind increased as the diameter of the cyclone contracted. The converse is probably true, that the force of the wind decreases as the cyclone's diameter increases. This may possibly explain why the gales on the British coast are less severe than the West Indian hurricanes; for the former are generally storms of very large diameter, while the latter are usually of comparatively small dimensions, expanding, however, after they have recurved to the north-eastward.

14. Cyclones must not be considered as cylindrical in form; they are in fact flat discs, whose height is supposed to be small compared with their diameters, and they have a concave upper surface, the cause of which will presently be shown. The axes upon which they may be supposed

to revolve are often inclined at a considerable angle to the horizon. We may thus conceive the rear of a storm to be tilted up, while its anterior semicircle alone impinges upon the earth; hence we see how it may be possible for a vessel to encounter only a portion of a cyclone, although the centre may have passed over her. Many of these severe storms appear and disappear so suddenly, that they have been supposed to have been whirled down from the upper regions of the atmosphere and then to have soared up again, after touching only a small part of the earth's surface. Many great storms have probably terminated in this manner, for it is frequently found impossible to trace them beyond a certain point; and we can hardly suppose the rotation to have ceased suddenly without previous symptoms of gradual subsidence.

15. It is almost impossible to give any notion of the extreme violence of the wind in a tyfoon or hurricane to persons who have never experienced one of these meteors, although the following Table gives an approximate indication of the force and velocity of the wind. A few incidents selected from numerous records of severe storms may serve as imperfect indications of the fearful force of the wind.

Pressure on One Square Foot in Lbs. avoirdupois.	Velocity in Miles per Hour.	Velocity in Feet per Second.	Observations.
.005	1	1.47	Hardly perceptible.
.020	2	2.93	Just perceptible.
.044	3	4.40	
.079	4	5.87	Gentle, pleasant wind.
.123	5	7.33	
.492	10	14.67	Pleasant gale.
1.107	15	22.00	
1.968	20	29.34	Brisk gale.
3.075	25	36.67	Very brisk gale.
4.429	30	44.01	Storm.
6.027	35	51.34	Great storm.
7.873	40	58.68	Tempest.
9.963	45	66.01	Violent tempest.
12.300	50	73.35	Hurricane.
17.715	60	88.02	Most violent hurricane.
31.490	80	117.36	
49.002	100	146.07	

We read of boats being entirely rent to pieces by the wind alone, of masts broken, although no sails were set, and of sails blown away from the masts on which they were furled and secured in anticipation of the tempest.

The most sheltered harbours afford no certain security in these terrific storms. That disasters should occur at Hong Kong need scarcely surprise us, but that vessels should be totally wrecked in Malta Harbour is a convincing proof of the strength to which a wind may rise, even in places supposed to be exempt from actual hurricanes.

When the "Raleigh" was upset in a tyfoon on the coast of China in August 1835, she was under bare poles. The crew scrambled upon the upper gunwale and managed to cut away the rigging; the masts for-

tunately were carried away, and the ship righted with no further damage than four feet of water in her hold.

Sir W. Reid records the following anecdote as an instance of the roaring of the wind in a hurricane. During the Barbadoes hurricane of 1831, Colonel Nickle, of the 36th Regiment, was standing under the arch of a lower window of his house; the roof and the upper story fell in, and, although the colonel was covered with dust from the falling ruins, the crash was perfectly inaudible.

The following occurrence is mentioned in Professor Dové's work; the minute details give the story an air of accuracy.

When Basseterre in Guadaloupe was destroyed by a storm on the 26th of July, 1825, General Baudrand states that three 24-pounders were borne away by it (in what manner is not stated, probably by the sea), and a piece of deal board 37 inches long, 9 inches wide, and 10 lines thick was hurled through a palm-tree 16 inches in diameter!

A still more wonderful fact is recorded in Professor Espy's work (Philosophy of Storms, p. 344), where it is stated that tin from the roofs of the houses of Natchez, on the Mississippi, was found at 20 miles' distance, and that a piece of a steamboat window was recognised 30 miles north-east of the town.

16. Such being the terrific fury of the wind in a cyclone, it becomes a question of the utmost importance to the seaman how to escape from the most violent part of these revolving storms. For this purpose the barometer is invaluable.

Since this instrument measures the weight or pressure of the atmosphere, it is evident that, if the height of the column of air above a barometer be diminished, the pressure supporting the mercurial column will be lessened, and the mercury, or, as we loosely phrase it, the barometer will fall. Bearing this fact in mind, let us examine in what manner the rapid rotation of the wind can affect the barometer.

17. When a rotatory motion is given to a fluid in a glass or jar, we find that the centrifugal force drives the water away from the centre, causing a depression at that point. In fact, the surface of the fluid, instead of remaining level, becomes concave. A similar depression takes place in the atmosphere during a cyclone; the air is spread out by the centrifugal force, and the heights of the atmospheric columns diminish gradually from the outer edge or circumference of the cyclone to the centre. We can thus explain, what experiment and observation teach us, that the barometer falls as the centre of a rotating storm approaches; and rises as that point recedes from the place of observation. Consequently it may be assumed as a general rule, that, the lower the barometer, the nearer is the centre of the storm.

18. The bearing of the centre is easily ascertained from the direction of the wind. In Plate I. we find that in the *northern* hemisphere with the wind at north, the centre bears east; wind at east, the centre bears south, and so on. In the *southern* hemisphere we must reckon the eight points of the compass between the wind and the bearing of the centre, in the opposite direction. Thus with the wind at north, the centre bears west; wind at east, the centre bears north, and so on. The incurving of the wind near the centre may in some degree modify this rule; but for all practical purposes it will be found sufficiently accurate.

19. Owing to the diameters of cyclones and their rates of progress being exceedingly variable, as previously noticed, all estimates of the distance of the observer from the storm's centre must necessarily be vague; but careful watching of the barometer, and of the changes in the direction of the wind, will generally enable us to form a tolerably accurate estimate of our distance from the vortex, and of the direction in which the whole body of the cyclone is travelling. The courses of the West Indian hurricanes, and of the storms in the Southern Indian Ocean, have already been pointed out; in the Bay of Bengal, and in the Chinese Seas, revolving storms generally move to the westward in a direction varying from north-west to west-south-west. Among islands and in narrow channels, hurricanes may frequently be deflected from their usual line of progression; in these cases, however, a seaman has rarely sufficient sea-room to avoid them; therefore, a knowledge of the direction in which they are moving becomes of less practical importance.

20. Although it is commonly found that the violence of the wind in a cyclone is greatest near the centre, yet at times the barometer rises before the most violent portion of the storm has passed. This peculiarity is probably caused by the upper part of the whirlwind moving forward more rapidly than the lower portion, which is retarded by the friction of the earth's surface. The axis of the whirlwind would thus be inclined forward, and the least atmospheric pressure might occur before the most violent part of the cyclone had reached the place of the observer. In considering the disturbance of the air by cyclones, we must remember that no *permanent* diminution of pressure at a spot can take place, for the equilibrium must speedily be restored by other portions of air rushing in to equalize the pressure.

21. Two remarkable phenomena, in some measure connected with great storms, may now be noticed. Nearly all severe gales are accompanied by a considerable rise of water at the places where they occur. The diminution of the atmospheric pressure is probably one cause of the rise of water. A fall of one inch of mercury denotes a diminished pressure on the surface of the water of half a pound on each square inch, in other words, a load of 72lbs. is taken off each square foot of water at that point where the barometer is the lowest; if, then, in addition to the greater pressure on the surrounding water, the wind in the cyclone should happen to blow towards the shore, we can easily understand how this wind would check the ebb, and increase the flood tide in great tidal rivers, such as the Hoogly and Yang-tse-kiang, and thus, by the two causes combined, great inundations might be occasioned.

22. A singular phenomenon is occasionally witnessed at St. Helena and Ascension, although these islands enjoy an exemption from gales of wind. Heavy *rollers* suddenly set in from seaward, breaking into a heavy surf where they reach the shallow water. It has been suggested that these rollers are caused by the swell arising from distant hurricanes. The "Julia" sloop of war was wrecked in October, 1817, at Tristan d'Acunha, an island about 1,300 miles south 15 west of St. Helena. The rollers suddenly rushed in, and in a very few minutes the vessel was totally destroyed.

23. Having thus described the peculiarities of revolving storms, and of

some of their attendant phenomena, we may now proceed to illustrate the manner of avoiding those portions of cyclones where the wind is most violent. By confining our attention solely to those gales of the northern hemisphere whose progress is in a westerly direction, we shall render this important part of the subject more easy of explanation. A seaman who understands the management of his ship in a cyclone of the *northern* hemisphere, will have little difficulty in applying this knowledge, should he encounter one of these storms to the southward of the equator. He must then reverse every operation: where he would have steered *north* in the northern hemisphere, he must steer *south;* east, west, and so on: or if the *starboard* tack was the safest in the *northern*, he will find the *port* tack the one to be preferred in the *southern* hemisphere. We may, in fact, assume as a general rule, that the *starboard* tack in the northern, and the *port* tack in the southern hemisphere will carry a ship away from the centre of the storm.

24. Before explaining the management of a ship in each quadrant of a cyclone, we must remember that the wind veers in a different manner in the northern and southern semicircles of a revolving storm. If the centre is passing to the northward of us, the wind being north at the commencement of the gale, we shall find that it veers round to north-west, then to west and south-west; but should the centre be passing to the southward, the wind veers from north to north-east, east, and so on. This difference has frequently perplexed seamen and other observers, and has given rise to the supposition that all revolving storms do not obey the same law, and that they occasionally revolve in either way in the same hemisphere; a consideration of the changes of wind which a ship must experience in each quadrant of a cyclone will explain this supposed anomaly. See Plate I.

25. *South-east Quadrant.*—Let us suppose that a vessel in a region where cyclones are likely to occur, has a strong wind from west or south-west, with a heavy confused sea; the barometer low, but rather inclined to rise; a heavy bank of dense black clouds hanging to the northward and north-westward. These are symptoms of a cyclone passing to the northward of the vessel, which is in the south-east quadrant of the storm. If bound to the northward, the only precaution to be used is not to make westing until the barometer rises and the weather clears. If bound to the southward, the vessel will be sailing away from the storm, she will therefore be in no danger of encountering it.

26. *South-west Quadrant.*—In this quadrant of the same or of a similar cyclone, the wind will be about north-west, and the central portion can easily be avoided, either by steering to the southward, if bound in that direction, or if bound to the northward, a vessel may sail round the southern part of the storm, keeping well to the southward until the change of wind and the rising of the barometer show that the centre has passed away to the north-westward. The winds will be north-west, then west, south-west, and finally south and south-east. The case of the French ship "Mansart," which will presently come before us, affords a striking example of thus avoiding the central portion of a cyclone.

27. *North-east Quadrant.*—The ship drawn in the north-east quadrant of Plate I. represents the "Pique," on the 11th of May, 1855, in the North Pacific, lat. 42° 43′ north, long. 168° 1′ east. In the morning a

fresh breeze was blowing from the south-east with heavy rain, which increased to a perfect deluge in the afternoon. Although studding sails and royals were set at half-past five o'clock, the wind increased so rapidly that by seven o'clock in the evening the ship was under close-reefed fore and main topsails and reefed foresail, running before a strong gale. At noon the barometer was 29·58, three P.M. 29·42; at eight P.M. it had fallen to 28·94.

The course steered was north-west; and, the wind being south-east, the centre of the storm bore about south-west, and it was probably travelling to the north-westward. At any rate, the rapid fall of the barometer proved that we were closing with the centre.

As this appeared to be a favourable opportunity for testing the accuracy of the law of storms in a region where few observations had hitherto been made, the course was altered from north-west to north-north-east; thus steering away from the centre. As anticipated, the barometer *immediately* ceased to fall; in half an hour it had risen 0·02; in an hour 0·07; and the weather began to clear. A dense heavy bank of clouds, out of which we seemed to emerge, and a heavy sea from the westward, pointed out the position of the severe portion of the cyclone. Having thus shown the immediate effect on the barometer, by steering away from the centre of the storm, the course was again altered to north-north-west, two points to the northward of our original course; the mercury still rose, but less rapidly than when we were steering north-north-east, and the weather improved, though more slowly than before. During the night the wind veered round from south-east to south; and at four A.M. it was blowing only a strong breeze from the south-west; the barometer having risen to 29·20.

On the day previous to this breeze, the wind was northerly, and the barometer rising, and during the previous night the weather was quite calm. This rise of the barometer and the dead calm frequently occur before the approach of a revolving storm. The rise of the barometer is attributed to the atmosphere being as it were heaped up in front of the advancing gale.

North-west Quadrant.—The last instance to be considered is the one of a ship in the north-west quadrant of the cyclone, which, in the northern hemisphere, and with a gale moving to the northward, is the most dangerous quadrant. Let us in the first place suppose a vessel hove to on the starboard tack to the southward of the path of the storm's centre; the barometer will be falling rapidly, and the wind will shift from north-east to north and then to north-west. The vessel would therefore be liable to be taken aback; she should therefore wear round on the other tack, or, what would perhaps be better still, she might steer to the south-westward until the barometer began to rise.

Should the centre be passing to the *southward* of the vessel, the wind would shift from north-east to east and south-east, and the starboard tack would be the coming-up tack, the wind drawing aft as the body of the storm passes over the vessel.

Only these few instances have been selected as illustrations from many others; for a vessel may be placed in every possible position with reference to the centre of a revolving storm; she may be running in advance of it; or following in the line of its path, and at the same rate at which the

storm is travelling, in which case the wind will not change; or a vessel may be occasionally dropping behind a storm, and then coming up with it again; and, finally, a ship may actually run round and round in a storm, as really happened to the "Charles Heddle," a fast sailing brig belonging to the Mauritius.

This vessel encountered a hurricane when about 196 miles north of that island, and she continued scudding for five days under bare poles at the rate of eleven and twelve knots an hour, marking out the peculiar cycloidal track shown in the lower portion of Plate IV.

Mr. Piddington considers the rate of progress of the body of this storm to have been only four miles an hour. We must remember that this circumstance occurred in south latitude, where the rotation of the wind is in the opposite direction to that of severe storms in the northern hemisphere.*

28. The next illustration of the law of storms which I shall bring to your notice affords a convincing proof of the correctness of the rotatory theory. A severe gale passed over Shanghae and its neighbourhood on the 7th and 8th of September, 1857. In collecting data respecting this storm it was found that a still more severe tempest, exhibiting all the characteristics of a cyclone, had passed over the north end of Formosa and across the channel between that island and the coast of China on the 3rd and 4th of September. See Plate V.

29. Commencing with the log-book of the "Antonita," we find her at anchor on the 3rd of September under the islands of Chinki and Taluk, in lat. 28° 6′ north, long. 121° 23′ east. As the gale freshened, a heavy swell from the south-eastward set into this anchorage, and gradually increased until the sea washed completely over the vessel. On September 4th, the "Antonita" weighed one anchor, slipped the cable of the other, and ran for shelter into Lotsin Bay, a short distance to the westward of her former position, and remained there until the gale moderated. It is evident that this vessel was in the northern semicircle of the cyclone, for the wind veered from north-east to east-north-east, then to east, and finally to east-south-east, when the gale moderated and the barometer rose. It reached its lowest point at noon on the 4th September, being then 29·40. The storm's centre, as fixed by the Peninsular and Oriental Company's steamer the "Cadiz," bore south-three-quarters-west ninety miles.

30. The "Lanrick," a famous opium clipper brig, belonging to Jardine and Co., furnishes us with observations in the southern half of the cyclone. The first symptoms of the approaching gale are noted on board this vessel on the 4th of September. A heavy confused sea is rolling from the north-eastward; the barometer and sympiesometer are both falling, while the wind freshens rapidly, first from west-north-west, then from west-south-west, moderating as it comes round to the south-west. The "Lanrick's" barometer reached its lowest point, 29·03, at 11 a.m. September 4. At noon on that day she was in lat. 24° 52′ north, long. 119° 47′ east; 67 miles south of the White Dogs, well known islands off the entrance of the river Min, which flows past the city of Foochow. The "Antonita" bore from the "Lanrick," north 220 miles, and the storm's centre, as placed by the

* The dates on the curved line show the ship's position at noon each day, and those on the straight lines, the estimated position of the storm's centre.

"Cadiz" at noon September 4th, bore north-north-east-half-east, 115 miles.

31. The winds blowing from opposite directions, experienced at the same time by the "Antonita" and "Lanrick," furnish a convincing proof that the centre of the cyclone passed between them—a fact we are enabled to verify by the accounts of the gale received from the "Waterwitch" and the steam-vessel "Cadiz."

32. Before describing the remarkable phenomena observed on board these two vessels, we may notice what occurred to the French ship "Mansart," the only vessel from which any information has been obtained respecting the weather to the eastward of Formosa. This vessel met the cyclone between the north end of that island and the small adjacent island of Kumi, in the evening of September the 2nd. Finding the gale to be freshening rapidly from the north-westward, with every indication of bad weather, Captain Gravereau bore up to seek shelter under the Meiaco Islands. As the gale increased, the "Mansart" continued scudding before it, altering her course so as to keep the wind right aft, as it veered round from north-west to west, and finally to south-west. She thus sailed round the southern semicircle of the cyclone, and eventually steered to the north-westward, passing between the Meiaco and Loochoo Islands, on the 4th of September, when the weather had moderated, and the wind had veered to the south-east. The "Mansart's" log-book shows the gale to have been at its height in the afternoon of September 3rd, the wind being then south-west. Calculating the position of the storm's centre at that time by the rate of progress obtained from its positions as noted on board the "Waterwitch" and "Cadiz," on the 3rd of September at midnight, and 4th of September at 11 a.m., we estimate its bearing and distance from the "Mansart" to be north-west 140 miles. The "Mansart's" barometer stood lowest, 28·31, from 4 p.m. to midnight, September 3rd. Captain Gravereau describes both the wind and sea as terrific; his crew were constantly at the pumps, and a portion of the cargo was thrown overboard to save the vessel from foundering.

33. Having thus noticed the strength of the wind, and its direction on board these three vessels, at some distance from the centre of the cyclone, let us now see what observations have been recorded on board the "Waterwitch" and "Cadiz," both of which vessels passed through the vortex of the storm.

34. During the whole of September 3rd the "Waterwitch" had a heavy gale from north by east to north. This steadiness in the direction of the wind is worthy of notice, indicating as it does that the vessel was lying nearly in the track of the advancing centre, whose bearing therefore remained unchanged. The aneroid barometer, as may be supposed, was falling very rapidly; if correctly registered it fell one inch and 3 tenths between 6 a.m. and midnight. At that time it was blowing a hurricane from the north, when the wind suddenly lulled and a complete calm succeeded. The sky was clear overhead, and the stars were shining brightly, while around the horizon all was gloom and darkness. An awful sea rose in huge masses and broke over the vessel on all sides, sweeping her decks from end to end. Birds were flying about in all directions, a fact likewise noted on board the "Cadiz." After about ten minutes of treacherous calm, the hurricane again burst forth with redoubled fury from the south, exactly the opposite

point of the compass. Until 10 a.m. the wind was terrific, the ship appeared to be on the point of foundering; it was found impossible either to cut away the masts or work the pumps, for the lascar crew were completely paralysed. The gale then moderated and veered to the south-eastward, but a "tremendous sea still ran mountains high." The lowest reading of the barometer was 28·35.

35. The "Cadiz," the Peninsular and Oriental Company's steamer, was about 15 miles north-north-east of Tungying at 10 p.m., on September 3rd. The weather looked threatening, the barometer was falling, and a strong gale blowing from the northward. Having to call off the White Dogs Islands for the mail from Foochow, Captain Aldham hove to on the port tack, the ship's head lying about east north-east. The gale increased during the night, but remained quite steady, showing that the centre of the storm remained on the same bearing as it approached the vessel. Between 5 a.m. and 11 a.m. the wind blew with the greatest fury. The storm then ceased, and a calm succeeded, lasting for about three-quarters of an hour. Birds and butterflies dropped on the decks in great numbers. Suddenly the hurricane again commenced with a blast from the south-south-east, veering gradually round to the eastward as it moderated. By keeping the engines going, the bow of the vessel was kept to the sea, which is described as tremendous, especially at the time of the sudden change of wind, when it appeared like a huge wall of water about to overwhelm the vessel. Fortunately none of the rigging from the spars carried away became entangled round the screw, for, had the engines been stopped, the "Cadiz" would most probably have foundered. Lowest barometer 28·40.

36. The log-books from which these facts have been taken are those of vessels whose positions were most favourable for observing the remarkable features of this cyclone. Observations made on board other ships prove this storm to have been of limited extent. Vessels to the southward of the "Lanrick" had moderate weather; but in all their log-books a heavy north-east or easterly swell is noted; and at Amoy, about 90 miles west-south-west of the "Lanrick," the tyfoon was not felt.

37. The "Friendship," a Siamese vessel, was seen dismasted on the 5th of September, in lat. 27° 2′ north, long. 121° 52′ east; the vortex of the cyclone must have passed very close to this vessel.

38. As might have been expected from the position of Foochow, the tyfoon was felt there in all its violence. During the night of September 3rd a heavy gale was blowing from north to north-north-west. At 9 a.m. September 4th, the barometer was 29·05, 11 a.m. 28·96, noon 28·88, 2 p.m. 28·68, and between 3 and 4 p.m. it reached the lowest point 28·58. The wind was then west; veering to the south-west, and blowing with terrific force, many houses were unroofed, and two are said to have been blown down. Several large trees were uprooted. Except among the Chinese craft, no serious disasters occurred to the shipping in the river Min. Captain Colville, of the "Camilla," then lying in the river Min, supplied me with this information. It is grievous to think that he and all his crew have lately been lost in one of these very tyfoons whose phenomena we are considering. The "Camilla" is supposed to have foundered in the neighbourhood of the Japanese Islands.

39. The insecure anchorage of Tamsui, at the north-west corner of the Island of Formosa, must have been greatly exposed to this severe cyclone. The information received from there is too slender to be worth noticing. It is a curious fact, however, that the rush of water from the river at Tamsui was so great that the ships were driven from their anchors *against* the wind. Two vessels drifted to sea and foundered.

40. Keelung Harbour lies about eighteen miles to the eastward of Tamsui on the opposite side of the promontory, forming the north end of Formosa. The ships at Keelung must have been in some measure sheltered by this promontory from the western portion of the cyclone. A Dutch barque, the "Jeannette and Cornelia," had been lying for some time in this harbour; her log-book notices that an exceedingly high sea rolled into the harbour on the 3rd of September.

It is a proof of the comparatively small diameter of this cyclone and of its slow rate of progress, that, while the weather was moderate at Keelung on the evening of September 2nd, the "Mansart," only fifty miles distant to the eastward, had a strong gale from the northward.

41. From the data obtained we may form a tolerably accurate estimate of the storm's rate of progress. Assuming the "Waterwitch" to have been in the vortex at midnight September 3rd, and the "Cadiz" to have been in the same predicament at 11 a.m. on the 4th, we can lay down these two positions of the centre. Drawing a line through them and producing it until within the shortest distance from Foochow, we thus ascertain the position of the centre when nearest to that city. The time when the centre arrived at this position is shown by the barometer, which reached its lowest point at 3 P.M. September 4. Now, measuring the distance between the two positions of the centre at midnight on the 3rd, and 3 P.M. on the 4th of September, we find that the storm has travelled 150 miles on a west-by-north-half-north course in fifteen hours, or at the rate of ten miles an hour. The same rate of progress results from taking the mean of the following estimates:—

Rate of Progress as measured

Between "Waterwitch" and "Cadiz"	.	7 miles an hour.
„ "Cadiz" and Foochow . .	13	„
„ "Waterwitch" and Foochow .	10	„
	3) 30	
Mean of the whole . .	10	„

42. Having thus noticed a few of the observations made during this severe cyclone, we may briefly recapitulate its most interesting features. We find it to be a distinctly marked revolving storm whose centre passed across the Formosa Channel between the 26th and 27th parallels of north latitude. Its course was nearly west-north-west, and its rate of progress averaged ten miles an hour. Beyond the "Antonita" to the north, and beyond the "Lanrick" to the south, the winds were comparatively moderate. That portion of the cyclone where the wind exceeded a strong breeze in force cannot be considered as more than 300 miles in diameter.

43. How beautifully is the truth of the law of storms confirmed by the winds noted on board the "Antonita," "Lanrick," and "Mansart." On the northern verge of the storm's circumference we see the "Antonita" lying in Lotsin Bay, the wind blowing a tyfoon from the eastward; at the southern limit, about 200 miles from the "Antonita," the "Lanrick" has a severe gale from the westward. East of Formosa the "Mansart" is flying before the gale, marking its rotatory character by her semi-circular track; while in the centre of the circle, on whose circumference these vessels are placed, the dismasted "Friendship," and the "Waterwitch" and "Cadiz" are lying helpless in the vortex of the cyclone!

44. Although this paper has already extended to a considerable length, the subject would be left incomplete without a few words on the origin of rotatory storms. In speculating upon the causes which produce these storms, we shall find that the peculiar conditions of the atmosphere by which cyclones are generated have not as yet been adequately explained. For, although the knowledge we possess of the winds in general affords some help in this investigation, the fact of our observations being almost exclusively confined to the lowest stratum of the atmosphere must ever render our knowledge of the aërial currents in some degree imperfect.

45. We know that the action of the solar heat on the atmosphere near the equator, combined with the rotation of the earth, give rise to the trade-winds. We also know that the monsoons are merely trade-winds, modified in their direction by the effects of the solar heat on the continents of Asia and Africa. The systematic veerings of the variable winds in the temperate zones have been explained by Dové's law of gyration, which is merely an extension of Hadley's theory of the trade-winds, and which must not be confounded with the law of storms. Hence it appears that winds blowing over any extent of the earth's surface are due to the action of the solar heat and the rotation of the earth.

49. The following Table shows that an intimate connexion exists between the periods at which cyclones occur, and the sun's motion in

No. of Years ascertaining.	Locality.	Authority.	Months.											
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
123	West Indies.	Nautical Magazine	—	—	—	—	—	1	2	13	10	7	—	—
59		United Service Journal, 1843, p. 3	—	—	—	—	—	1	5	13	13	9	—	—
39	South Indian Ocean, 1809 to 1848	Reid. Thom. Piddington	9	13	10	8	4	—	—	—	1	1	4	3
24	Mauritius, 1820 to 1824	Transactions Royal Society, Mauritius, 1849	9	15	15	8	—	—	—	—	—	—	—	6
46	Bay of Bengal, 1800 to 1846	Piddington	1	—	1	1	7	3	—	1	—	7	6	3
64	China Sea, 1780 to 1845	Piddington	—	—	—	—	—	2	5	5	18	10	6	—

declination. For in the northern hemisphere the greater number of cyclones occur in August and September; while in the southern hemisphere they are most prevalent in the corresponding months of February and March. And, although all parts of the earth are occasionally visited by severe storms, the most destructive are chiefly confined to the inter-tropical regions, always excluding the immediate vicinity of the equator, where they do not occur. The paths of cyclones, as shown in Diagrams III. and IV. likewise indicate that most of these storms commence near the limits of the trade-winds.

47. That the rotation of the earth should have a marked influence on winds extending over large tracts of the globe need not surprise us, if we bear in mind that the velocity of a point rotating at the equator is, in round numbers, 1000 miles an hour. At lat. 30° it is 800 miles an hour; at 40°, 766 miles an hour; at 50°, 643 miles an hour, and so on; varying as the cosine of the latitude. It is therefore easy to understand that a portion of air with a velocity of 1000 miles an hour from the west, descending to the earth's surface at lat. 40° where the velocity is only 766 miles an hour, will have the effect of a westerly wind of about 200 miles an hour. From this we must make a large deduction for friction, resistance of other strata of air, &c.; still there is a sufficient residual excess of velocity to account for the modifications which winds undergo in proceeding from the equator to the poles; and a converse effect will be produced where winds are moving from the poles towards the equator. In the former case the winds become more and more westerly in each hemisphere, while in the latter case they gradually become more easterly. The south-west return current, or anti-trade-wind of the northern hemisphere, and the north-west anti-trade wind of the southern hemisphere, are instances of the *first* species of winds; while the great trade-winds of both hemispheres exemplify the latter description of winds, or those moving from high latitudes towards the equator.

48. Without going further into the tempting, but too extensive, subject of the winds in general, enough has been stated to demonstrate the all-prevailing influence of the solar heat and of the earth's rotation; and to convince us of the connection between rotating storms and the prevailing winds. We may therefore infer, that winds and cyclones arise from the same causes.

It now remains for us to investigate in what manner these causes produce the *rotatory motion* and the *progressive* movement, by which these remarkable meteors are characterised.

49. There are many ways in which we can conceive rotatory storms to originate; two lateral currents of air from different directions may cause a horizontal whirlwind; or the upper aërial current may suddenly meet a portion of the lower current moving in an opposite direction and with a different velocity, thus producing a vertical whirlwind; and whirlwinds may arise at any intermediate angle between the horizontal and the vertical.

Various explanations of the origin of rotating storms have been given by writers on the subject, many of which are exceedingly vague and unsatisfactory; even Professor Dové, whose law of gyration can be so

readily understood, becomes confused and unintelligible when attempting to account for the origin of cyclones.*

50. Without dwelling longer on these hypotheses, I must call your attention to an explanation of certain kinds of whirlwinds, which is given by Sir John Herschel in the new edition of the "Encyclopædia Britannica." This explanation deserves to be studied, as it seems to reconcile the *rotatory* theory of Redfield with the *centripetal* theory of Espy. See Plate VI.

Bearing in mind that the figure of Plate VI. is drawn for the *northern* hemisphere, let us suppose that, owing to the application of local heat, the air over some extensive locality *C* should ascend in a vertical column; to supply the place of the air so ascending, an indraught from all the surrounding region will commence.

Let the equal lines *N n*, 1 1, 2 2, &c., represent the forces and directions of the currents drawn in from equidistant points, situated to the north, north-north-east, north-east, &c.; then, were the earth at rest, these currents would all press towards *C* with equal force, and the lines *N n*, &c., would be terminated by a concentric circle, and a mere vertical ascending current without gyration would result. But since the earth revolves from west to east, the air coming from the higher latitude at *N* will have a *less* velocity towards the east than the air at *n*; the result will therefore be a wind not *north*, but from a point to the eastward of north; we must, therefore, take *na* to the *westward* of *N* in such a proportion that, *na* : *Nn* : : difference of the velocities at $N \times n$: the velocity of the indraught. Join *Na*, which will then represent the relative force and direction of the current setting in from north. A similar construction being made at every other point, the system of relative currents will be represented by the arrows *Na*, 1*b*, 2*c*, &c. For it is evident that the air rushing towards *C* from *S* has a greater velocity towards the *east* or from the west than the air near *C*; consequently on this, the southern side of the diagram, the resultants must be drawn to the *eastward* of the original directions which the winds would have under the supposition that the earth remained at rest.

A bare inspection of the figure shows that such a system, terminating in an ascensional movement over the tract *C*, can be no other than a vortex or spiral eddy in the direction of the internal curved arrow; that is, in a direction contrary to the motion of the hands of a watch. In the southern hemisphere it will be the reverse, as will appear on drawing the figure.

It is also obvious that the force of the wind at the vortex must be in proportion to the strength of its producing causes.

In high latitudes there is a deficiency of solar heat and aqueous evaporation to produce a sufficiently powerful ascending current. On the other hand, at the equator, where there is abundant heat, the other generating cause, viz. a difference of diurnal rotatory velocity is wholly wanting.†

A whirlwind of this nature, Sir John terms a "whirlwind of rarefaction," to distinguish it from "whirlwinds of compression" to be hereafter noticed.

51. In this description of the origin of a whirlwind, the influence of the

* See page 15 of No. 8 of "Meteorological Papers," published by the Board of Trade.
† Art. Meteor, p. 650.

earth's rotation is clearly exhibited; but we are not told how the progressive movement of whirlwinds is produced.

If this movement is to be attributed to the prevailing winds, and if cyclones are to be considered as borne along by the great aërial currents in the same manner as a whirling eddy is carried away in the stream of a river, most of our difficulties will disappear.

Notwithstanding the support which the West Indian hurricanes and the storms near the Mauritius seem to give to this hypothesis, I fear that it does not hold good in all cases; for many rotating storms have been experienced in other parts of the world where their progressive movement cannot be due to any prevailing wind.

Both in the Bay of Bengal and in the Chinese seas storms are very frequent at the period of the change of monsoons, when no prevailing wind can be said to exist, and yet the tracks of storms are usually in the same direction. In the Formosa Channel the storms generally pass across that strait from east to west, which is nearly at right angles to the direction of the prevailing winds.

52. From all these considerations it may be fairly assumed that the precise manner in which progressive rotatory storms are produced has not yet been adequately explained.

53. One more phenomenon remains to be noticed. Small whirlwinds or whirlpillars are frequently seen at sea, where they produce waterspouts, and at times they have been observed revolving within the greater cyclones. These peculiar gyrations of the atmosphere, termed by Sir John Herschel "whirlwinds of compression," are most common on the hot and arid plains of India and on the sandy deserts of Africa, where they have been noticed chasing each other in rapid succession, overturning tents, and carrying away in their vortices any light articles they may meet in their paths.

Professor Daniel considers an atmosphere, floating over heated plains such as these, to be in unstable equilibrium, or in other words, as liable to be disturbed and set in motion by the slightest cause. The dense surrounding air will consequently break in at times, and produce horizontal revolutions, and vortices of greater or less extent.

We cannot, however, apply the phenomena of these whirlpillars to the solution of the problem we are considering, since they do not follow the general law of rotation of the greater cyclones; for they have been seen to revolve in *both* directions in the *same* hemisphere.

54. If the rotatory motion of the greater storms be really due to the rotation of the earth, as already explained, we can readily understand that mere local whirlwinds are not necessarily subject to the influence of that rotation, which cannot have any effect, unless the currents of air producing the whirlwind extend over a sufficient portion of the earth's surface to embrace considerable differences of latitude.

55. In the whirlpillars noticed on sandy plains, the air becomes highly electrical, a phenomenon which is probably caused by the friction of the particles of dust against the earth's surface, and possibly against each other. This development of electricity, as well as the electricity displayed in most storms, has induced some persons to suppose that cyclones are caused by electricity. We are too frequently tempted to invoke the aid of

electricity when the causes of physical phenomena lie beyond the scope of our limited knowledge, but in the present instance electricity cannot help us; for the most trustworthy meteorologists consider the electricity exhibited during severe storms to be an *effect* and *not a cause*. They are of opinion that it arises from the condensation and precipitation of aqueous vapour, and from other atmospheric changes, to enlarge upon which would carry us far beyond the limits of the special subject under our consideration.

56. In connection, however, with electricity or magnetism, a remarkable fact has been glanced at by Sir W. Reid, in his first work on storms. The islands of Mauritius and St. Helena lie nearly in the same latitude; yet the neighbourhood of the former island is a noted hurricane region, while St. Helena is exempt from even moderate gales of wind. Now it has been proved by careful observations that the magnetic intensity of the earth is a *minimum* at St. Helena. Sir William has also noticed that the meridians which pass through two of the four magnetic poles likewise pass through the Chinese and the Caribbean Seas, the chief localities of tyfoons and hurricanes; and in these regions the earth's magnetic intensity is most strongly displayed.

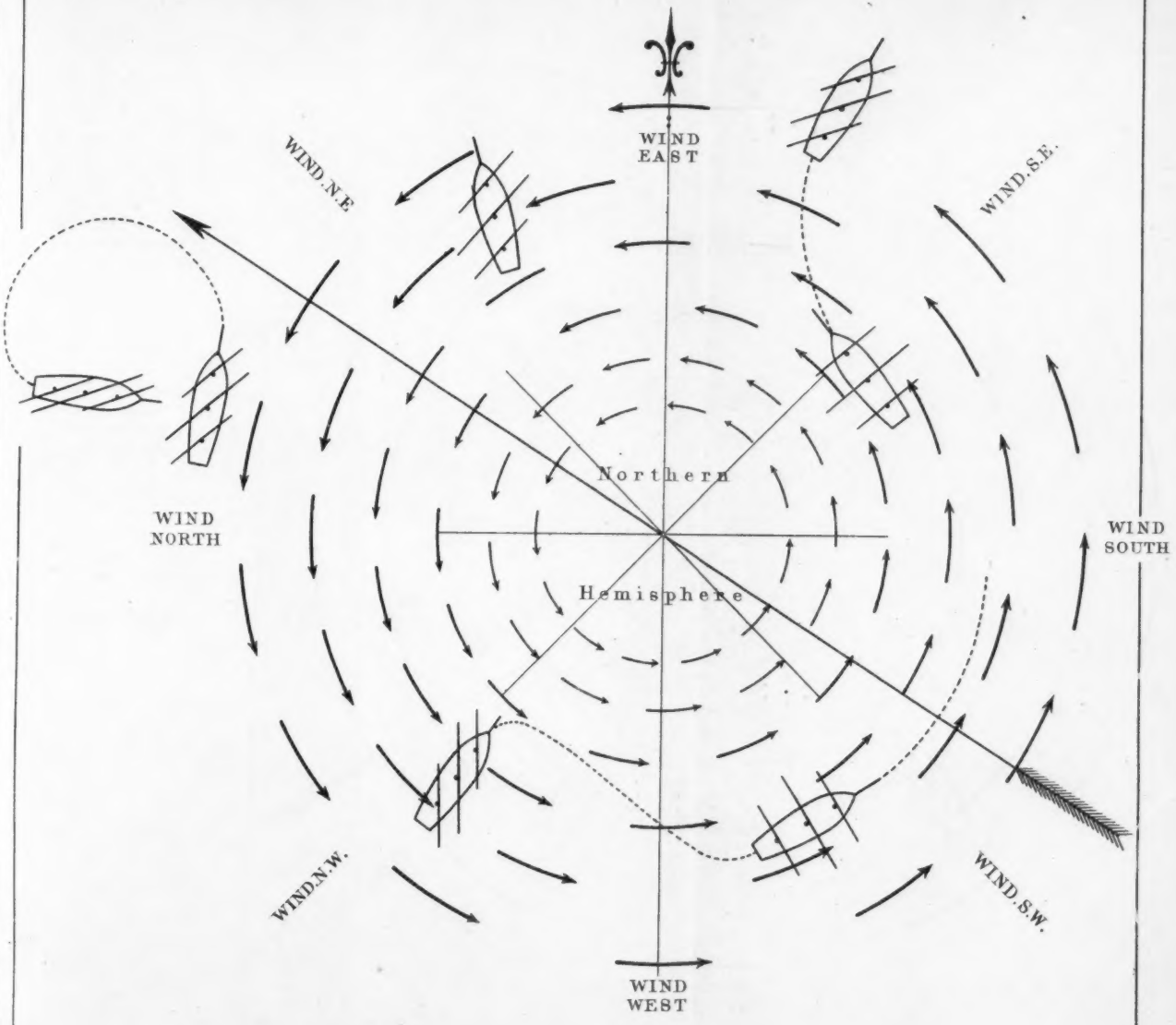
57. I venture to suggest another explanation of the difference between these two islands with respect to the prevalence of storms; and of the causes which render the Chinese and Caribbean Seas so famous for cyclones. If we examine a map of the world we shall find that the hurricane regions lie *chiefly*, if not *entirely*, on the *eastern* or *weather* sides of the great continents. Taking Asia and the Eastern Archipelago and Australasia as one continent, and Africa and America as the two others, we find a hurricane region on the eastern coast of China, and another on the north-east coast of Australia, in the neighbourhood of New Caledonia. In the northern part of the Indian Ocean, the prevalence of land has a considerable modifying influence on the aërial currents; yet we find that hurricanes occur on the east coast of Hindostan, and at the north-east part of Africa, while on the east side of South Africa, near the Mauritius, we have a well known and better defined hurricane region. On the eastern side of the continent of America, the West Indian hurricanes and the pamperos and severe storms near the mouth of the river Plate, form a striking contrast to the moderate winds on the western side of that continent; for the occasional storms on the west coast of Mexico are generally considered as the western semicircles of the West Indian hurricanes. On the western coast of Africa heavy storms are unknown; the tornadoes of that region, though probably whirlwinds, are mere local disturbances of the atmosphere. These considerations seem to afford a plausible explanation of the immunity from cyclones which St. Helena enjoys, and point out the remarkable connection already alluded to between the trade-winds and rotatory storms. Without pursuing these speculations any further, I trust enough has been stated to prove the importance of meteorological observations, and especially of *simultaneous* observations carried on through long periods of time, and over wide areas of the earth's surface. The more our knowledge respecting storms is extended, the greater will be the security to our ships and to their crews and cargoes. The seaman acquainted with the law of storms is doubly armed against their violence; for he can generally avoid

the most dangerous part of a hurricane, and may even make the storm subservient to the prosecution of his voyage. The knowledge of this law, which has already proved so useful to all whose business lies upon the great waters, was acquired by the collection and study of observations made at sea. Therefore, let no one, whether seaman or landsman, suppose that his observations are valueless, but let all who have the opportunity add their information to the common stock of meteorological knowledge.

In every branch of science increased knowledge leads to the conviction that the laws which regulate the phenomena of nature are few in number, and simple in their character. Chemical research has reduced the elementary substances to a small number, which will probably be still further diminished the more diligently that science is cultivated. Electricity and magnetism have been proved to be identical, and there are indications that heat and light result from a similar cause. Our astronomical knowledge assures us that one all-pervading influence, which we term gravitation, gives stability to the system of the universe. Throughout the material, and likewise in the moral world, we see evidences of unity of design carried out by simple and immutable laws. To the discovery of these laws our best endeavours should be directed; an object only to be attained by observing and recording the phenomena around us. Let this be done in meteorology, and we may then confidently hope to see that science fully elucidated. When future philosophers, aided by diligent observers, shall have accomplished that task, the laws which govern the winds and the waves will no doubt prove to be as certain in their operation as those by which the movements of the heavenly bodies are regulated.

Although the seaman exposed to the terrific fury of a hurricane may fail to perceive the utility of these devastating whirlwinds, we cannot doubt that they have been ordained for some wise and useful purpose. Could we but scan the wonders of nature with the eye of Omniscience, we should cease to marvel at these seeming anomalies. For we should then acknowledge that cyclones, like other apparent evils, are not capricious interruptions of the harmony of nature, but essential parts of the vast scheme of divine beneficence.

> All Nature is but Art, unknown to thee;
> All Chance, Direction, which thou canst not see;
> All Discord, Harmony, not understood;
> All partial Evil, universal Good!—POPE.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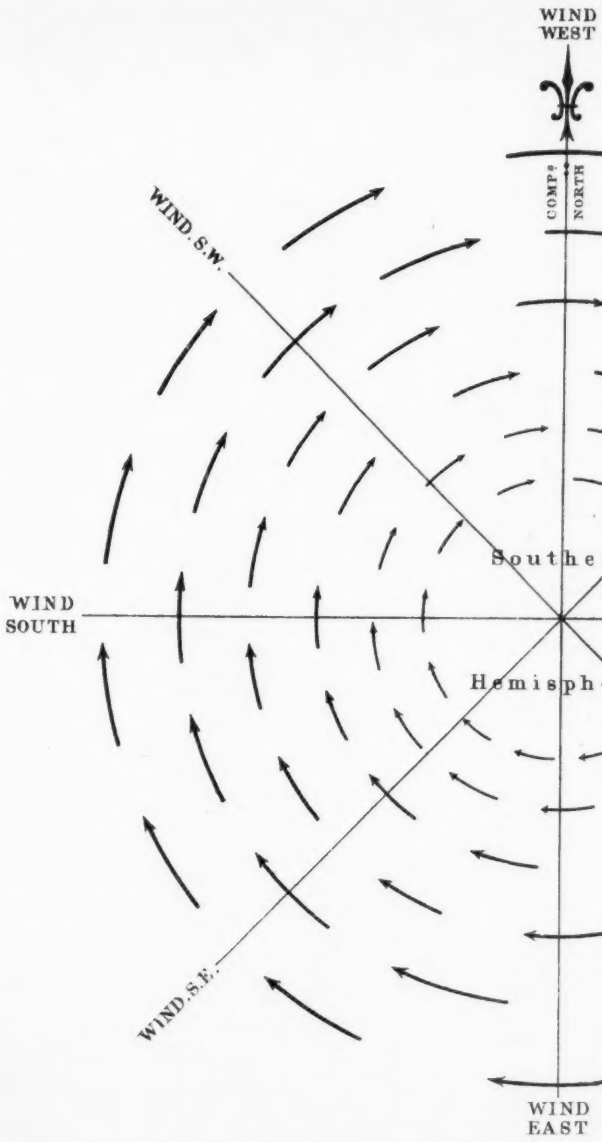
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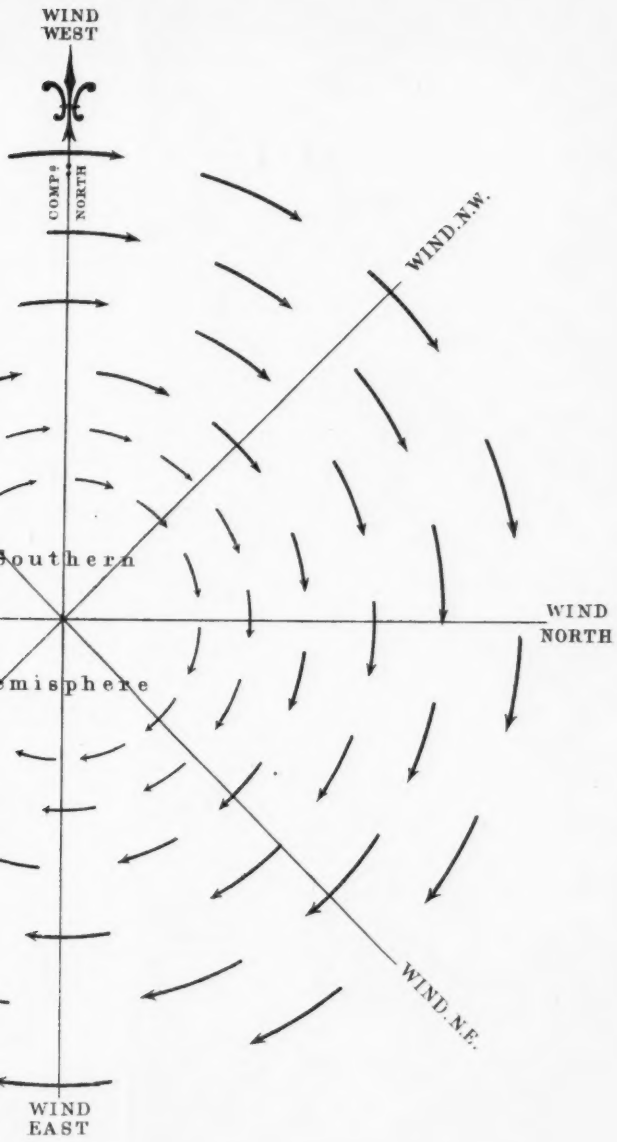
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Pl. III.
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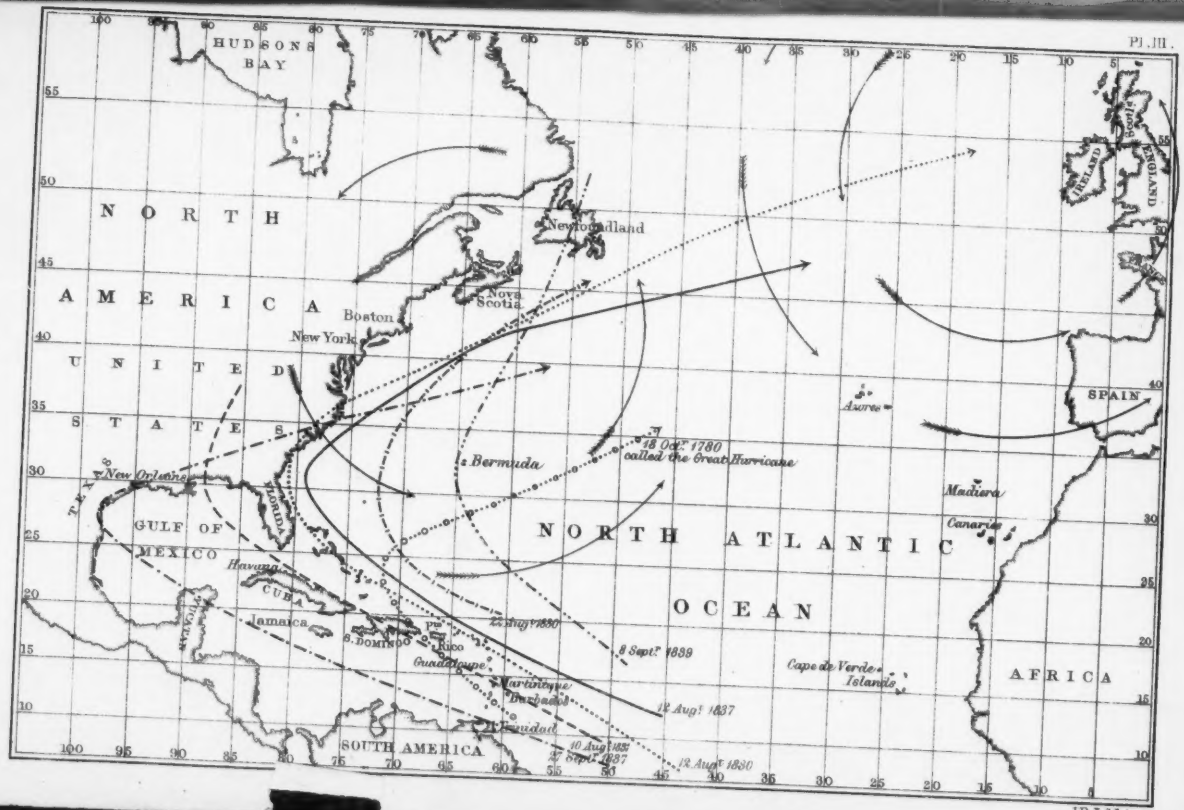
HUDSONS BAY
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New York
UNITED STATES
New Orleans
TEXAS
FLORIDA
GULF OF MEXICO
Havana
CUBA
Jamaica
S. DOMINGO
P.co Rico
Guadaloupe
Martinique
Barbadoes
Trinidad
SOUTH AMERICA
Bermuda
18 Oct.r 1780 called the Great Hurricane
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Canaries
Cape de Verde Islands
AFRICA
SPAIN
IRELAND
ENGLAND
FRANCE
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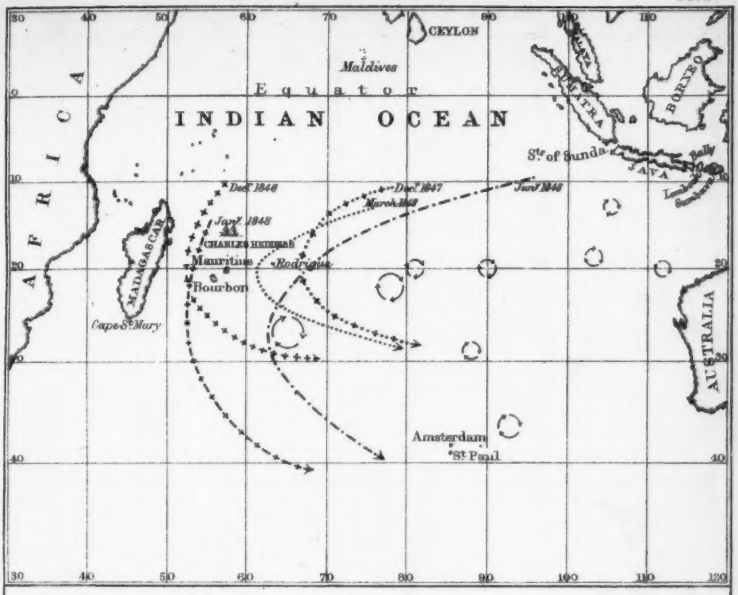

THE CHARLES HEDDLE'S HURRICANE.

Latitude 16.42 S.
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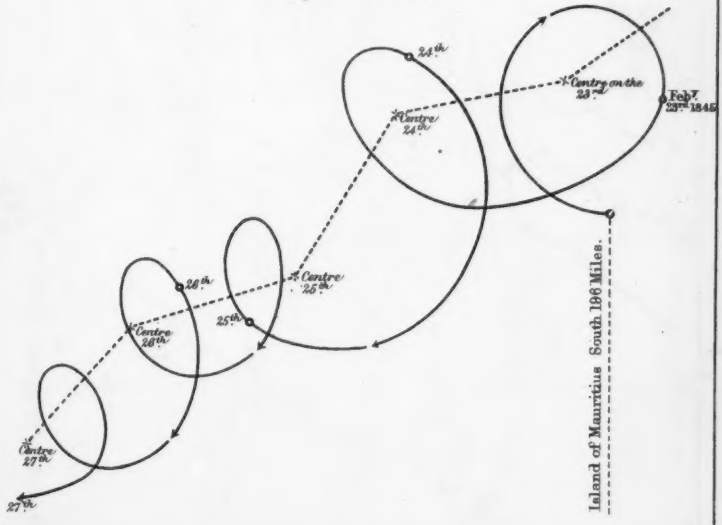

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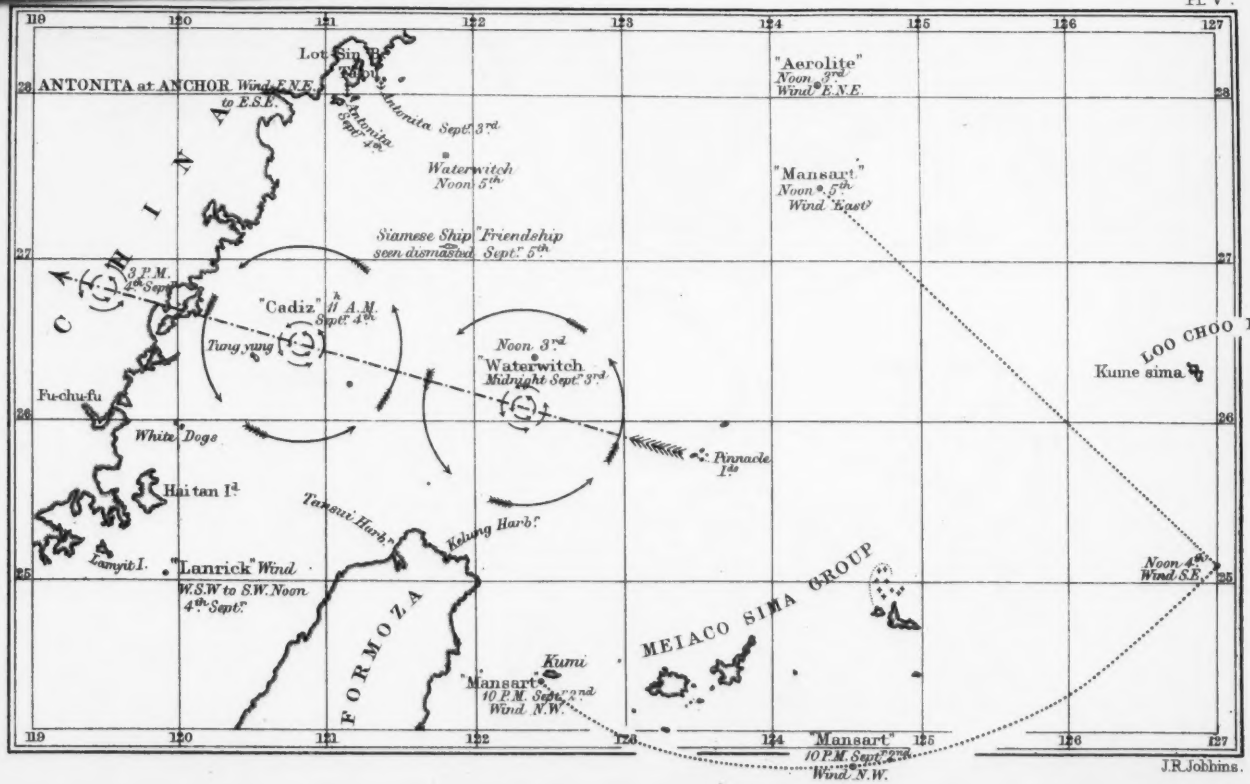
Pl. V.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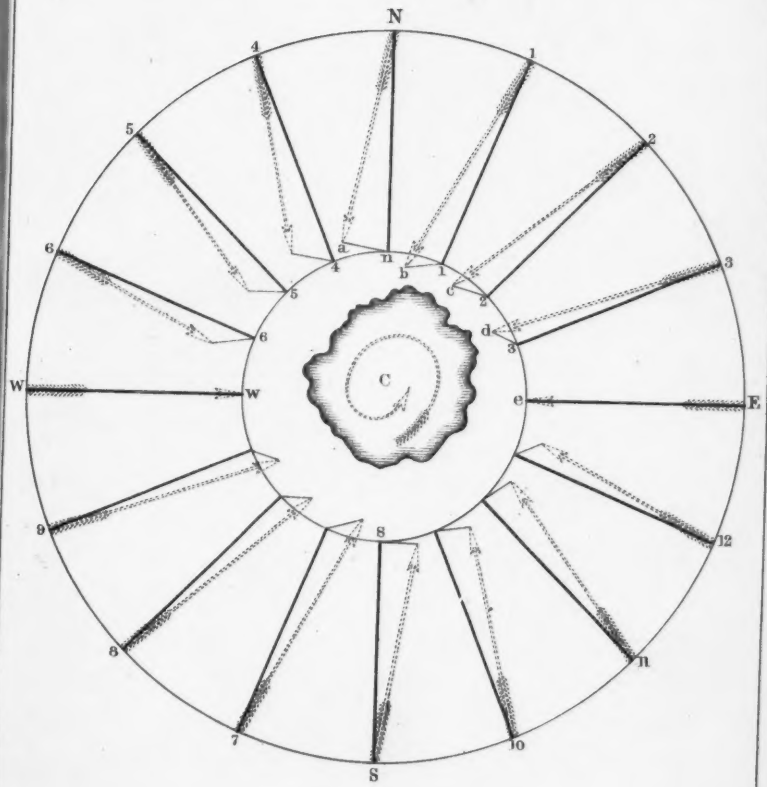
ANTONITA at ANCHOR Wind E.N.E. to E.S.E.
Lot Sin Ba
Antonita Sept. 3rd
Antonita Sept. 4th
Waterwitch Noon 5th.
"Aerolite" Noon 3rd. Wind E.N.E.
"Mansart" Noon 5th. Wind East?
Siamese Ship "Friendship" seen dismasted Sept. 5th.
3 P.M. 2nd Sept.
"Cadiz" 11 A.M. Sept. 4th.
Tiang yang
Noon 3rd.
"Waterwitch" Midnight Sept. 3rd.
Fu-chu-fu
White Dogs
Pinnacle Id.
Hai tan Id.
Tansui Harb.
Kelung Harb.
Lamyit I.
"Lanrick" Wind W.S.W to S.W. Noon 4th Sept.
CHINA
FORMOZA
MEIACO SIMA GROUP
Kumi
Mansart 10 P.M. Sept. 2nd Wind N.W.
LOO CHOO Is
Kune sima
Noon 4th Wind S.E.
"Mansart" 10 P.M. Sept. 2nd Wind N.W.

J.R.Jobbins.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Friday, April 19th, 1861.

MAJOR-GENERAL THE HON. JAMES LINDSAY, M.P. in the Chair.

Friday, May 17th, 1861.

CAPTAIN E. G. FISHBOURNE, R.N. C.B. in the Chair.

NAVAL ORDNANCE.

By COMMANDER ROBERT A. E. SCOTT, R.N.

THE importance of the subject on which I have the honour of addressing you, has been very much enhanced by the fearful conflict which seems on the eve of commencing in America; and who can say how long peace may be preserved in Europe, or what effect this sad struggle may ultimately have upon our own finances?

To my mind at least, this unnatural war looming in the distance, and the agitated state of Europe, have rendered it of the utmost consequence that the large sums now being expended upon our coast defences, ships, and guns, should be laid out so judiciously as to preclude a hasty re-construction in case of war, and a state of transition that might even imperil our maritime supremacy.

Let us therefore first examine what naval warfare *has* been, and how far these conditions have been changed, and then whether such changes have been met in the present and proposed armaments; so as to have a clear view of our preparedness to meet every contingency.

Our greatest naval commander, whose victories were really "conquests," not satisfied with giving as his final instructions "that no captain could do very wrong who placed his ship alongside an enemy," was accustomed to fasten at the top of his highest mast the signal, "Engage the enemy more closely." "And at Trafalgar, leading the weather column in the 'Victory,' and brushing the 'Bucentaure's' stern, Lord Nelson poured in a broadside that killed or wounded 400 men and dismounted twenty guns; and whilst his crew were listening with characteristic avidity to the deafening crash made by their shot in the hull of the French flag-ship, they were nearly suffocated with the clouds of black smoke that entered the 'Victory's' port-holes, and their heroic commander and his officers on deck were covered with the dust that issued from the crumbled wood-work of their enemy's stern."

Have the circumstances really changed since then? No. And, although we have longer ranges, we have and are fast getting better protected vessels, so that the change is merely one of degree and not of kind, and will not influence the distance at which naval actions will be fought. Sir Howard Douglas, in his last gunnery pamphlet, says, "that it is derogatory to the character of the British seaman to say that he would prefer *the iron sides of a slow vessel* to the velocity of the craft that would at once bring him alongside an enemy." Indeed, nearly all those actions which have been attempted to be fought at a distance are those we have most reason to be ashamed of, and when we give up our confident rush, our unhesitating assurance of victory, and prefer to remain at long balls, cowering under the lee of shoals or behind bulwarks, it will be a dark day for Britain.

Decisive battles have been, and will ever be, fought at close quarters, in confusion and smoke, amidst the dying and the dead, as when the American frigate "Chesapeake" succumbed to the English "Shannon" with guns dismounted, carriages destroyed, 179 of her crew killed and wounded, and her decks streaming with blood.

Need I say that there must be simplicity of gun and simplicity of projectile under such circumstances, and that length of range is but a secondary consideration. On this point I may quote an extract from a speech made at the Civil Engineers' Institute by Sir W. Armstrong, who seems to have mastered the works of foreign artillerists, as well as the opinions of our own, and whose early training eminently qualified him for sifting the valuable from the useless. He says, "The public was always captivated by the attainment of long ranges, but great delusion prevailed on that subject." And again, "That however perfect the weapons might be made, the fate of a battle would never be very materially influenced by very distant firing. The real struggle would always lie within a distance of 2,000 yards, and the first consideration should be to make the weapons as destructive as possible within that limit."

Having thus indicated the necessity for simplicity of gun and projectile, it is hardly necessary to point out, that non-liability to injury from blows or rough usage is also essential for close fighting; and as there would be little time for extra polishing and oiling, and guns would have to be kept uncovered in war, it is likewise requisite that no parts of the gun should be liable to be affected by the weather.

In order to arrive at the essentials for a naval gun, it is necessary to glance at the improvements which have been made, and to compare the destructive effects of rifle projectiles with those of the round ball at the distances at which decisive naval actions have been, and will still be, fought.

Bearing in mind then that length of range is but a secondary consideration, and that distant firing against plated ships would be wholly thrown away, and were it not so, that British pluck and dash could not *then* be brought into play, we have now to inquire which weapon has hitherto proved the best for close quarters. The answer is, the smooth-bore gun; numerous careful experiments having shown that the solid 68lb. round ball fired from the old 68-pounder has a far greater smashing effect than the elongated shot from the new service rifled 100-pounder.

This superior result is due to the higher velocity of the round ball, and, as velocity^2 × weight = force of the blow (approximately), it is easily seen, why the 68lb. round ball has, besides making a larger hole, a more smashing and shaking effect on iron, stone, or wood, than a shot of much smaller diameter coated with soft metal. Besides this greater effect, the round ball is more easily loaded, and hence is better adapted to the exciting and critical moments of "close quarters."

The "Times'" correspondent with the field force in China, in his spirited report published in that paper, stated that the new rifled field piece proved inferior to the smooth bore for close quarters; he said, "That the range seemed too close (for the Armstrongs,) so three of Desborough's 24-pounders were ordered to the front, and in five minutes the Chinese fire was effectually silenced." And in another place he wrote, "At short ranges under 300 yards, however, the old round 9-pounder, and the 24-pounder howitzers, seem to be more efficient than the conical shell. Desborough's guns, beautifully served, were the most successful against the Creek Battery." These were smooth bores.*

The round ball, from rolling over in the bore on the first pressure of the elastic fluid, occasions comparatively little strain or jar on the gun, while the rifle shot, on the contrary, has to be fairly shoved out along the spiral groove, which detains it. This detention, till the shot un-threads itself, causes the elastic fluid generated by the combustion of the powder to be much compressed, and to react from the shot against the bottom and sides of the bore with great violence, a strain which is very much increased when the windage (the safety-valve of weak guns) is closed, and a leaded projectile of larger diameter than the bore has to be first started, and then driven through rifle grooves almost instantaneously.

Having thus laid before you the first essentials of a naval gun, viz. simplicity and non-liability to injury, and having shown that the round ball, besides being more destructive for close quarters, is more easily loaded, and is discharged with incomparable less strain on the gun than the elongated shot, it remains to add, that as the navy are trained to fire low, and therefore a large proportion of shot strike the water before hitting, it is very important that naval projectiles should ricochet straight. This the round ball does, and, besides always striking fairly, it has a flatter trajectory up to 2000 yards, and a much flatter one up to 1000, than the fine groove rifle projectiles.

It is generally supposed that the 68 lb. round ball, having, as I have already mentioned, rolled over in the bore, maintains a slight rotation for 600 yards, up to which distance it is very accurate, but after this there is a sensible and increasingly rapid falling off, both in speed and accuracy. As a shell, the round ball, from its small capacity, is very inferior either for shrapnel, powder, or the fearful molten iron. It is true that the round ball can be made red hot, but this is attended with danger to the gun, and is not easily carried out on board ship; its effects also are trifling compared with those of the stream of molten liquid which the larger elongated shell would pour out. This shower of fire would enter every aperture, and drive the men from their guns, after the shell had first delivered its blow on the vessel's side. Thus we see, that in some cases,

* See note at page 431.—Ed.

such as a first broadside and for the purposes of distant bombardment and for accurate fire, to cover boats attacking an enemy, or troops landing in the face of one, the elongated shell is very superior to the round; but for a hand-to-hand engagement and close battering, greater results can be obtained from the solid round ball, and with far less strain on the piece.

Let us then sum up the points for a naval gun, and examine closely how far these have been met in former guns, and whether any of the plans at present proposed have succeeded in meeting these requirements. This will enable us to judge whether a combination of such qualities can be obtained from any one gun, and if not, what points should be sacrificed so as to secure the essentials of simplicity and smashing effect, with as many other good points as can be united in the same weapon.

A naval gun then should,

1st. Be simple in its construction,
2nd. Be not liable to injury from blows or weather,
3rd. Fire a shot of large diameter (from 8 to 10 inches or more,)
4th. Be able to use the smashing round ball at close quarters,
5th. Give a flat trajectory,
6th. Have projectiles which deflect little, and ricochet straight and evenly,
7th. Fire elongated molten iron shells,
8th. Fire elongated powder shells, near or across ships, &c. with safety,
9th. Fire shrapnel or built-up shells over boats with safety,
10th. Fire canister.

This last is essential for gun-boats to sweep the banks of rivers; a shell cannot replace it for close quarters. A large diameter is included in the above list, for without great size the round ball would have little smashing power, nor could a high velocity be obtained from elongated shot, unless they offered a large area in proportion to length for the powder to act upon, in propelling them. The captivation of the public with long ranges has led to lengthening the projectile at the cost of its efficiency, and has occasioned one great advantage of rifling to be overlooked, viz. the power it confers of shortening the gun without much loss of effect, owing to the detention of the shot and the consequent earlier combustion of the charge. The use of leaded (forced) projectiles, and breech loaders, has even caused a step to be taken in the wrong direction, first by rendering the adoption of a slow-burning powder to lessen the strain on the gun, and then a lengthening of the barrel in order to give the powder time to burn, a necessity.

The first of the qualities enumerated as essential for a naval gun is met in the existing smooth-bore guns, but they are deficient in the last points, and are also inaccurate at long ranges. Inaccuracy, however, at long ranges is not of vital importance, for errors in pointing, in naval warfare, are three to one greater than those which result from the inaccuracy of the guns. Up to breaching distance, however, accuracy is of considerable moment, and especially for shore operations. The deficiencies in the smooth bore, have been long observed, and in 1845 and 1846 they were attempted to be supplied by M. Wahrendorf and Colonel Cavalli. Both these gentlemen adopted breech-loaders and tight-fitting shot; the

former using principally a leaded projectile and several shallow grooves, and the latter, an iron shot with two grooves.

The former plan was adopted by Prussia, the latter by Sardinia; and although the lead-coated shot were at first most in favour, both they and breech-loading have now been discarded by nearly all the continental nations.

The French commenced making trials of two shallow elliptical grooves, out of which they fired some projectiles with a long and some with a short bearing. These were entirely of iron, the rifle twist being in the former case equal throughout the bore, but in the latter increasing towards the muzzle. Although, when tried in England, the plan gave greater accuracy than that of the early oval, saw-grooved, or two grooved breech-loader, the French do not seem to have been satisfied with their own system, and in December, 1860, changed their plan to the present three grooves, with which they have rifled their heavy ordnance.

This groove is similar on its bearing side to that adopted by myself more than a year before, only it has an additional piece taken out on the opposite side for facility of loading. See Plate II. figs. 17, 18, and A.

The rifling, like my own, is intended to fire round shot, but the French have retained the increasing spiral, and are consequently forced to have a short bearing, a button, which is of zinc on the side which takes the groove in coming out of the bore; the other half of the button is of iron, and cast with the projectile. In the field gun the buttons are wholly of zinc and more numerous, and they are somewhat differently arranged.

The Prussians, however, having early pushed forward the rifling of their old guns and made a large number of new breech-loaders of Krupp's steel, as well as new breech-loaders of cast-iron, have adhered to lead-covered shot, and this, as Fourcault alleges, "because they are unwilling to incur the expense of change to a non-leaded projectile."

It is right that I notice the fact that, in 1780 or 1790, Manton rifled a brass service gun with a number of shallow rectangular grooves, and fired a projectile, having a wooden sabot affixed to its rear for the purpose of taking the rifling, and there were previously a few other experiments, as well as some subsequently, which produced little result. Manton's rifled gun is still lying in the Arsenal.

But it is now time to examine how far these and other systems of rifling meet the requirements of Naval Warfare, and in doing so it is necessary to distinguish between the grooving itself, and the gun which receives it. For instance, any wrought iron coil gun used by Sir W. Armstrong might have its rifling changed from the many groove to three grooves; and this particular coil structure of gun is that used by Blakely and others.

Leaving therefore the full details of the structure and metal of guns for some future occasion, I wish to bring before you the present plans of rifling, which may be all classed under four distinct systems. These are—

1st. The Compression.
2nd. The Expansion.
3rd. The Centring against the Bore.
4th. The Concentric.

1st. *The Compression.*—This plan was early adopted and perfected by the Prussians, who obtained very great accuracy and range, using a

charge of only one-tenth the weight of the projectile, and, as it is the first successful application of a lead-coating plan, I will particularly describe it.

The Rifling consists of numerous shallow rectangular grooves similar to those used by Manton. These are sixteen or eighteen in number in the field piece, and proportionately more in larger guns.

The Projectile is encircled by four rounded lead bands or hoops (See Plate I. figs. 1 and 2) which have their outer surface of larger diameter than the bore. The gun is therefore necessarily loaded at the breech, the aperture being closed by a solid wedge pushed across the bore, and the leakage of gas prevented by a valve and a papier-mâché cup, which by the explosion of the powder are pressed tightly against the wedge, effectually stopping all escape of gas.

The vent is bored through the gun itself. After discharge the wedge is drawn back and the cup pushed through the gun with the sponge, which leaves the bore open from end to end.

The simplicity of this plan recommends it as the best method of breech loading that has yet appeared, and the lead on the projectile having plenty of space to yield does not strip; from the same cause the friction in the bore and strain upon the gun are comparatively small.

To facilitate loading, the breech chamber is of larger size than the remainder of the bore; into this, the projectile and powder are quickly and easily placed, and as no leading occurs, the rapidity of fire is considerable. The wedge, however, according to the French, is liable to get set fast by rust or grit.

Of these guns very little was known until recently, and then it was found that the Prussian field pieces gave a range and accuracy equal to those of the more finely grooved English weapon, and with a less charge, viz., with one-tenth instead of one-eighth the projectile's weight. The 24-pounder of cast iron threw a shell of 56 lbs., which contained a large bursting charge, with similar precision.

The next compression rifling is that called the fine-groove, or Armstrong plan. The grooves are thirty-eight in number in the field piece, and seventy-six in the gun of seven inches bore, called a 100-pounder.

These grooves had a figure nearly rectangular when first adopted for the service, but are now sloped out on one side (see fig. 3); the original rifling was that shown by Fig. a.

The depth of the grooves is not equal throughout the bore, the lands being sloped out towards the centre to lessen the friction; the bore and depth of the grooves are the same just in front of the breech chamber and at the muzzle.

The projectile is coated with lead hardened by an admixture of tin. In the earlier shot there was an opening or score near the centre for the lead to strip into, the surfaces of the lead being otherwise nearly straight, but lately the metal has been reduced in front and the score made nearer the heel, which is now the largest part of the shot. (See fig. 4.)

By this alteration the friction has been greatly reduced, for only the rear of the shot now goes down to the bottom of the rifle grooves; and, while the strain on the gun has been lessened, the range and accuracy have been increased.

This change, and the rounding out of the sides of the grooves which are

(SKETCHES)

COMPRESSION SYSTEM.

Prussian

1

Section of Segment of Gun

Manton 1790. also used by Lynall Thomas.

2

Lead

Iron Shell with external Grooves filled by Lead covering

Lead covering in Grooves

Ribbed Lead covered Shot

Armstrong

3

Segmental Transverse Sections of Rifling.

Original Groove (Saw)

Adopted Groove.

Present Groove.

4

Lead covering

Half Elevation of Shell with Grooves filled by Lead covering

Half Elevation of Shell and Lead covering

5

Transverse Section of Gun

SHUNT PLAN

EXPANSION SYSTEM.

Transverse Section of Guns.

Jeffry

Section of Shell.

7

Lead dovetailed at rear of Shell.

8

9

Section of Segment.

Saw Groove

Used by Blakeley with Leaded Shot and by Col. Wilmot with Iron Shot

Britten

Transverse Section

10

of Shell

a. a. a. a. Lead affixed to Rear of Shell by Zinc b. b. Wood Plug Screwed on

6

a. a. a. a. Zinc rib shewn much raised

b. b. b. Grooves to facilitate compression

c. c. c. Cast projection to support Zinc rib

Elevation of Shot

The dotted lines shew Shell

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opposite to those that drive or give rotation to the shot, has greatly decreased the fouling and tendency to strip.

Instead of the wedge plan of breech loading adopted by Prussia, the fine-groove gun has a stopper, held in its place by a breech screw, and through this the charge is introduced, the stopper being lifted out of the gun for that purpose.

The vent opening is made in this stopper, called a vent-piece, which in the larger ordnance necessitates double priming, that is, a small charge called a primer is placed in the lower part of the aperture which communicates immediately with the bore, before the stopper is lifted back into the loaded gun. The screw is then hove tight, and the usual friction priming tube introduced into the hole in the top of the vent-piece.

Let us now compare this finely grooved piece with the requirements for a naval gun:

The first was, it should be "simple in construction."

The finely grooved weapon consists of many parts, and its rifling is very delicate, while the deflecting sight increases the time and difficulty of pointing.

The coils of which the gun is made, though exceedingly strong to resist direct internal pressure, often show flaws after firing, and the gun is easily injured by blows; the coils are also liable to separate.

These flaws and this separation are partly occasioned by the want of a muzzle swell, which occasions a strong reaction, injuriously acting upon the piece after each discharge.

This was shown by the 100-pounder which was returned from Shoeburyness badly cracked in the inner tube of the breech, and in another gun also sent back on account of a smaller flaw in a similar part.

It was also equally apparent in the 12-pounder which failed and became wholly disabled in the ordinary practice at Shoeburyness.

2nd. It should "not be liable to injury from blows or weather."

The damage sustained by blows on the outside was shown in the experiment of firing with a 9-pounder smooth bore brass field piece at a rifled 12-pounder coil gun, and also at a 9-pounder brass gun. The charges were very much reduced, so as to resemble the effect of distant firing. In this trial, the 12-pounder was broken to pieces in three rounds, each blow being alone sufficient to disable it, while the 9-pounder, after receiving the same number of shots on one side, sustained a similar discharge against the other, and remained still serviceable for discharging grape, case, or 6-lb. round balls. In fact, but for one blow on the thinnest part of the chace, the gun could have continued to fire its usual ammunition, and, while the broken breech loader would have perhaps not been worth removal from the field of battle, the brass gun could have been made as serviceable as ever in a couple of hours.

The separation of coils has frequently happened "in proof" with both 40 and 100-pounders, and also took place with one 120-pounder shunt, and may be expected to happen on service, from the concussion and friction resulting from the jar before the leaded shot starts, and the strain of driving it through a hole of smaller diameter than itself.

The number of pieces the gun is composed of greatly increases the chances of mishap. For instance, in China the vent-piece flew out

when the gun was most required to check the Tartars, and after a night's rain the breech-screws of one battery were set fast. At Shoeburyness also the vent-piece flew out of the 80-pounder while being fired by the Select Committee; and lately a 12-pounder vent-piece did the same in trying penetration into wood.

The grooving easily gets injured. This was shown by Mr. Baring, who stated in the House what had happened to a 100-pounder "which had been sent to Portsmouth, but not to be fired, as it had been somewhat injured by a shell bursting at its mouth;" and other instances of injury from the shot breaking through the lead-coating whilst under proof have also occurred.

The deflecting sight is required, from the lateral deviation of the fine-groove projectile from the straight line; but so delicate and perplexing a sight would not answer where the distances are constantly changing. This lateral deviation is caused by the excess of weight of lead and iron in the rear of the projectile; and this excess, which is required by the peculiarities of the system, will not allow its axis to remain tangential to the trajectory, and thus causes the shot to decribe a lateral curve, deviating more and more from the straight line as the velocity of flight and rotation lessens.

3rd. It should "fire a shot of large diameter, from 8 to 10 inches."

The 100-pound projectile has less than 7 inches diameter of iron, and the 40 and 25-pounders about 4·7 and 3·6 inches respectively, which is a trifle more than the diameters of the 12 and 6-pound round balls. The 40 and 25-pounders are, therefore, of little use for broadside firing, and of no great use for bombardment, their shells containing only 2½ pounds and 1 pound of powder.

4th. "Be able to fire the smashing round ball at close quarters."

This cannot be done without damaging the grooves.

5th. "Give a flat trajectory."

The great friction in the bore, and the lengthening of the projectile, in order to gain powder capacity and great range, considerably reduce the velocity, and consequently the flatness of trajectory. From these causes, the range of the 100-pounder at 1 degree of elevation is little over 500 yards—a distance which is attained by the 68 and 32-pound smooth-bore guns with about half a degree of elevation.

6th. "Have projectiles which deflect little and ricochet straight and evenly."

The weight of the projectile being in the rear causes it to turn over if the point be arrested; so that the shot would probably strike sideways, instead of delivering a straight and full blow on ricochetting. The weight in the rear also keeps the point of the shot raised, instead of following the trajectory; this diminishes the penetration. Future warfare may prove that such projectiles, from being so readily and often so unevenly deflected, must be very cautiously used in supporting a friendly vessel.

In breaching the tower at Eastbourne at 1,052 yards, it was observed that, while some of the rifle projectiles penetrated from 7 to 8 feet into the brickwork, others did not pass through more than from 1½ to 2 feet. This difference was probably owing to some of the shot striking less fairly than the others. A familiar illustration of a somewhat similar effect is afforded

by the difference between hitting a straight and a bent nail; for, while the former easily penetrates hard wood, the latter will make but comparatively small impression.

7th. "Fire elongated molten iron shells."

This may be done in target practice, using a very small charge, but can scarcely be effected in naval warfare; for the heat soon expands the shell, and then a vast increase of strain in forcing it through the bore ensues, which greatly augments the danger of the shells crushing up in the gun and destroying the grooving.

A short time since two 100-pounders were placed at 700 yards from the section of a wooden vessel at Shoeburyness, and the charge was reduced from 12 to 6 pounds of powder; despite the lessening of the charge, which prevented precision of fire, the vent-pieces of both guns were broken, before much damage was done to the wooden side.

8th. "Fire elongated powder shells near or across ships, &c."

This cannot be ensured, as the enormous pressure renders the shell liable to crush up.

At the Eastbourne experiment several shells burst at the muzzle, and the grooves of the 100-pounder howitzer were filled with lead, the projectile necessarily going wide of its mark. I saw a more striking instance of the effect of stripping at Shoeburyness. The gun was pointed and fired by an experienced naval gunnery captain, and the projectile went so far to the left, and so short withal, as to go close over a marine artillery officer and party, who were laying out a target on another range. At Woolwich also, during the trial of initial velocities with the ballistic pendulum, the screens were much cut up by the stripping, and had to be changed. In the Chinese campaign,* pieces of the lead coating of the projectiles fell on the skirmishers of the 44th.

Lord Herbert, in moving a vote of thanks to the forces, remarks:—

"It is said by Sir R. Napier that he never saw forts better defended. His words are worth quoting:

"'The enemy made a noble and vigorous resistance; no entry had yet been made, the breach had not been completed; the gate was

* With reference to the Author's statement as to what occurred in China, we think it fair to our readers and Sir William Armstrong to subjoin the following letter from Major Hay, R.A., late Assistant Adjutant-General, Royal Artillery Expeditionary Force in China, to Sir W. Armstrong, which has been published since the delivery of the Lectures.—Ed.

"2, Coates-crescent, Edinburgh, 25th March, 1861.

"Dear Sir William,—It was not my intention to have taken any notice of the article which appeared in the *Mechanics' Magazine* of the 1st of March, headed 'The Armstrong Gun,' it being so utterly at variance with the substance of my actual reports.

"But my attention having been called to an article in the *Morning Post* (22d March), copied from the *Mechanics' Magazine* of the previous week, commenting on the speech made by Mr. Baring when laying the Army Estimates before the House, in which the writer in the boldest way challenges the production of my report to substantiate, I imagine, his former statement, I am induced to write to you, in order that you may, should you deem it necessary, contradict in any way the statements contained in those articles.

"The Armstrong guns in China rendered the most valuable service, being always in the most efficient and serviceable condition, although put to very severe tests. They were never withdrawn from action and their places supplied by others; on the contrary, the Armstrong guns were invariably the first to be ordered up when artillery was required. At Tongchow, on the 14th of August, and again on the 21st, at the capture of the Upper

known to be built up; the attempts of the French to escalade at their angle were unsuccessful. At this juncture, with the permission of the Commander-in-Chief, I brought up two 24-pounder howitzers, and two 9-pounder guns of Govan's, to within eighty yards of the rampart, which, firing over the heads of the men on the 'Berm,' cut away the parapet at the point where the defence was most obstinate."'

9th. "Fire shrapnel or built-up shells over boats with safety."

Similar dangers occur here to those already pointed out, and, if the lead coating be firmly attached to the projectile, it does not break up well, but I will refer to what happened in China, where the stripping already noticed, joined perhaps to the superior battering effect of round ball, as shown in the first experiment at Dover, seems to have been the cause for smooth bore guns alone being brought up at the most critical part of the whole campaign.

10th. "Fire canister."

This cannot be done, and shell cannot replace it; every shell too, intended to burst and scatter its contents and its own pieces before striking any object, requires two fuses, as the lead, by closing the windage, prevents the usual lighting of the time-fuse by the explosion, and therefore renders an additional percussion arrangement necessary, doubling the chances of a miss-fire, or a premature explosion, if the composition be disturbed.

The next compression plan of rifling is that of the shunt, which, instead of numerous fine grooves, consists of three double grooves with sharp edges and corners, and the projectile, instead of being coated with lead, hardened by zinc, has three zinc strips driven into it. These form the bearings of the shot, and they are let in by means of three undercut grooves along its surface, the grooves being of greater width in front than at the rear, to allow the strips to be driven home. See figs. 5 and 6.

The peculiarity of this mode of rifling is the additional groove, which, as now developed, is exactly as if three grooves, like those of the service rifled musket, were laid upon three plain grooves. To understand this, it is necessary to know that the musket grooves are deeper at the breech than at the muzzle, and, as a necessary consequence, the portions of lead which on discharge were expanded out to the bottoms of the grooves, the portions, in fact, that took the rifling, become more and more compressed as the ball travels onward to the muzzle where the grooves are shallowest.

North Taku Fort, the Armstrong batteries were firing over the heads of our infantry in advance, and the guns never ceased firing in consequence of any casualty to our men—quite the reverse; those guns continued firing while the infantry advanced to storm the enemy's works. It would have been most surprising if slight alterations had not suggested themselves in both guns and ammunition, considering that they were being tried for the first time, and that they were most jealously watched by all.

"In fact, from the instructions I received before leaving England, it was my duty to point out the slightest defect. This I did, and I was glad to observe, in a recent visit to the Royal Arsenal, Woolwich, that those defects had all been remedied in a manner which experiments had proved to be most successful; and I now feel confident that the British Artillery have the first gun, with the most perfect ammunition, in the world.

"I am, yours very faithfully,
"R. J. HAY, Brevet Major Royal Artillery,
"Late Assistant Adjutant-General, Royal Artillery Expeditionary Force, China.

"Sir W. G. Armstrong, C.B., &c."

This shallowing of the grooves is perfectly even throughout the musket barrel from breech to muzzle, but the bore itself is of uniform diameter.

The bore of the shunt is likewise uniform, and the incline regular. In the earlier guns of 1859 and 1860, the incline commenced behind the trunnions, and was only placed upon one groove, then on two grooves, and now the incline is upon all three grooves, only commencing at one and a half or two feet from the muzzle. It is also less steep, and the groove itself is shallower than at first.

The name "shunt" tends to mislead—the fact is, that, as the projections of the shot could not be loaded through the compression groove, sufficient width is allowed in the deeper groove beside it for the projectile to pass easily by the compression incline; at the end of which, the groove is narrowed to prevent the escape of powder, and not allow the projectile to have too much play on starting.

It is here necessary to ask you to bear in mind that, just as a male screw is pushed into a female screw pressing upon one side, and is withdrawn resting against the opposite side, so the muzzle loading rifled projectile goes in with its projections bearing against one side of the spiral grooving, and comes out on discharge pressing against the other, which, by obstructing its passage causes it to turn round or rotate.

Hence then the projectile when rammed home lies against the loading side of the groove, and on receiving the pressure of the elastic fluid is forced against the opposite side of the groove.

In the shunt gun the projectile, after striking the flat surface of the groove against which it has to slide, and unthread itself, goes generally along the bottom of the bore until it reaches the three inclines, when the compression commencing gradually, as already shown, squeezes the ball up into the middle of the bore, so that it leaves, centered and tightly nipped.

On the equality of this nipping, or rather on the equality of the yielding of the zinc strips, accuracy wholly depends, but as a fall, or even a knock, would alter their position, and the squeeze throws a great strain on the gun, the plan is hardly a suitable one for naval warfare.

Indeed the plan was abandoned after the bursting of many strengthened cast-iron guns, and a plain flat groove was tried; but as no accuracy could be obtained from this it was given up, and the shunt again returned to.

The double groove of the shunt cannot be easily sponged, owing to its sharp corners and edges, and were these edges to be rounded, or to become worn, the zinc strips would slip over the rifling.

The tight nip at the muzzle, though less dangerous than when the compression commenced further back on one groove only, which necessarily made the shot glance off to the opposite side of the bore, is still very destructive to the gun, as shewn in the opening of the heavy wrought iron shunt gun in proof, and the wear of the compressing grooves.

The modification of the shunt system, consisting in reversing the grooves and projections by making the former in the shot and placing the latter upon the bore, was equally unsuccessful, one of the ribs of a wrought iron gun giving way after about 100 rounds.

In comparing the shunt with the standard, it seems, like its many-grooved predecessor, to come short on the first 4 points, and not to have

hitherto been a success on the 5th and 6th. With regard to the 7th, viz. to "fire elongated molten iron shells;" this can hardly be done; for the expansion of shot caused by the molten iron filling, would increase the strain on the gun, and likewise increase the severity of the nip upon the bearings of the expanded shot.

This tighter nip would increase the projectile's tendency to crack, for the heavy liquid metal renders all shells filled with it very liable to break before they become thoroughly heated.

Comparative safety might be obtained by reducing the charge, but this would, in most cases, sacrifice much of the accuracy and destructive effect of the shell.

8th. "Fire elongated powder shells near or across ships with safety."

This cannot be insured, for portions of the zinc strips are liable to break off, and the slightest loosening in carriage, &c., would, on firing, cause the strips to be jerked out of the projectile when nipped at the muzzle.

9th. "Fire shrapnell or built-up shell over boats with safety." The same objections apply here.

10th. "Fire canister."

This could be done, but at the risk of destroying the sharp edges of the grooving.

System of Expansion.

From the compression, we have now to turn to the expansion system.

This plan was adopted by Mr. Lynall Thomas both in service cast-iron, and in a large forged gun made for him by the Mersey Company.

The weight of his gun, which was left rough, was about six tons, the diameter of the bore 7 inches, and from it the longest ranges, and the greatest known velocity of rifle projectiles, have been obtained.

The gun has been fired with 25lbs. and 27lbs. of powder, and with projectiles weighing 175lbs., and these were thrown about 10,070 yards.

The rifling is similar to that used by Mr. B. Britten, but the grooves are more numerous, and the expansion, which seems more perfect, is effected in a different manner, by driving out a hard metal.

The twist of the rifling was sharper than that used by others who had adopted the expansion system, and the ranges were very equal.

The 2nd expansion plan is that of Mr. Jeffrey, who has ably applied the principle of the Minié bullet to ordnance projectiles. (See figs. 7 and 8.)

The rifling consists of several shallow elliptical grooves, the number being proportioned to the calibre of the gun.

In the 32-pounder last rifled, there are seven grooves, which leave rather more one-third of the bore as "land," the rest being cut away by the rifling.

The 32-pounder projectile weighs about 44lbs. when empty; of this the lead weighs 14lbs., and the powder capacity is about 2½lbs.

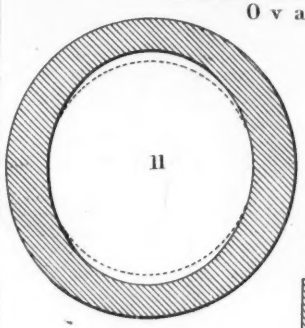
The lead is affixed to the rear of the projectile by dovetails, into which it is cast, and a hollow resembling that of the Minie bullet is left at the bottom, for the purpose of causing the lead to expand out into the rifle grooves.

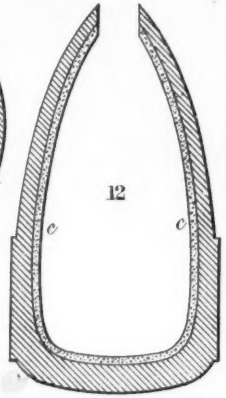
A wad or covering, consisting of flannel coated with soft soap, is

(SKETCHES)

CENTERING AGAINST BORE. SYSTEM.

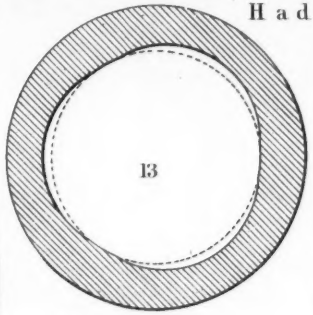
Lancaster's Oval

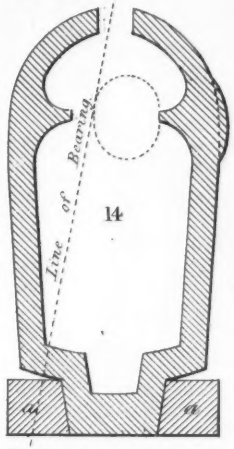




c. c. Loam lining for Molten Iron.

Haddan's

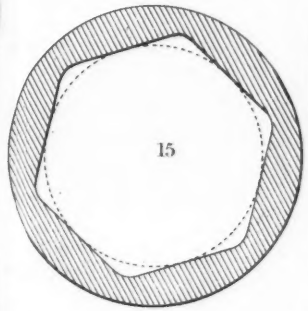


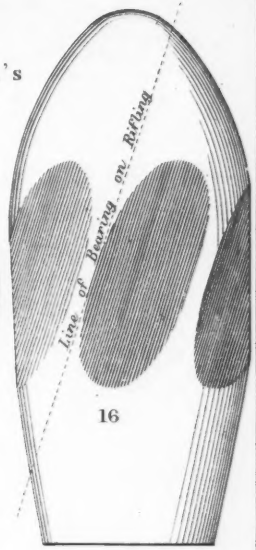


a. a. Circular Wad

Haddan has lately used a flat bottomed Shell

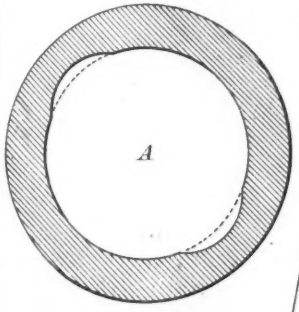
Whitworth's (Hexagon)





Elevation of Shot

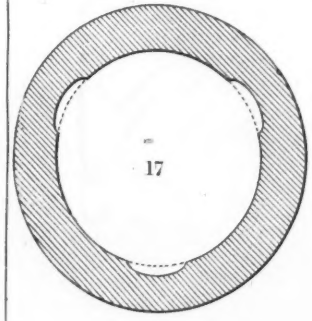
Early French

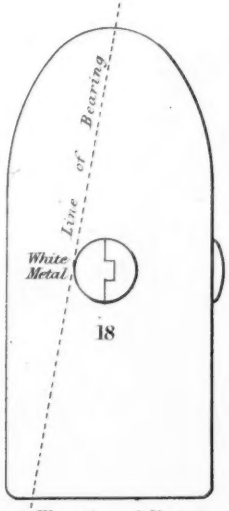


CONCENTRIC SYSTEM.

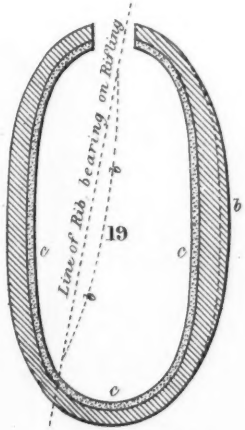
Scott's

French, Dec^r, 1860

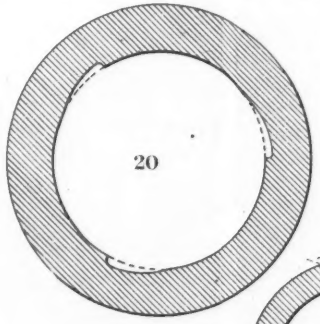


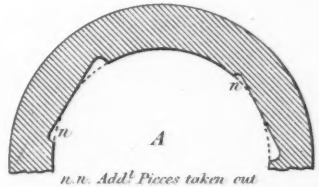


Elevation of Shot



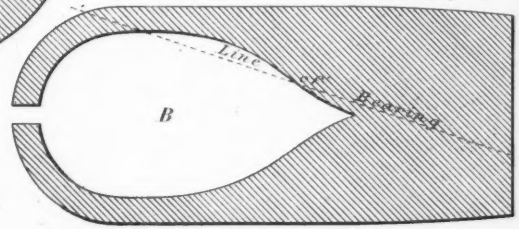
Balanced Shell.
b.b. shews Rib on Shell.
c.c.c. Loam lining.





n.n. Add^l Pieces taken out for large Calibers.

Solid headed Shell for 1^st Broadside, &c.



J. R. Jobbins.

wrapped round the rear of the projectile, and this facilitates the loading, decreases the windage, and lubricates the bore of the gun.

The 3d expansion plan is that of Mr. Britten.

The rifling consists of shallow rectangular grooves, removing half the surface of the bore.

In the 32-pounder there are seven grooves (see figs. 9 and 10).

The 32-pounder projectile weighs about 48lbs. empty; the lead, which weighs about 14lbs., being affixed chemically to the plain surface of the casting by means of zinc; a wooden plug is screwed on to the bottom of the projectile, which, being driven against the lead on discharge, causes it to expand into the grooves. Captain Blakely has used this shot with a triangular groove.

The difficulty experienced in the expansion plans is that of keeping the axis of the projectile coincident with the long axis of the piece. At low elevations, the friction along the bore tends to raise the rear of the shot, and facilitate the equal expansion of the lead; but, if the lead at the rear expands equally, it is clear that the iron forepart of the shot, having nothing to raise it, must continue to rub along the bottom of the bore. At high elevations, however, the shell keeps more fairly along the bottom of the bore, the lead on its upper surface expanding the most. An illustration of this is found in the greater accuracy obtained at high as compared with that obtained at low elevation with the same gun.

The accuracy also is found to be lessened by a slow twist, and hence it is essential that the bearings of the projectile be sufficiently firm "not to slip," a result difficult of attainment with a heavy shot and a metal sufficiently soft to expand out into the rifling.

The expansion of the lead at the rear of the projectile increases as the combustion of the powder becomes more perfect from the bore's warming; and hence, when the gun is weakened by being heated, an increased strain is thrown upon it, by the sharper driving out of the lead into the rifling and more instantaneous closing of the windage.

The lead, however, has the advantage from its greater weight of maintaining rotation better than iron only; but this advantage is more than counterbalanced by the loss of powder capacity, and the slow initial velocity of the projectile.

System of Centring against the Bore.

1st. Mr. Lancaster's plan:

The gun is rifled as an oval, by which only a trace of the original bore is left at the lesser diameter, called the minor axis of the piece. The greater diameter, or major axis, being, in the last 32-pounder, about six-tenths of an inch larger than the minor, so that, considered as a two-groove rifle, the grooves are three-tenths of an inch deep at their centres. (See Plate II., Figs. 11 and 12.)

The earlier projectiles, namely, those sent to the Crimea, were made of wrought iron, with no rifle twist upon them, but more recently the shot have been bent to the shape of the bore; some of these had a wrought iron casing put over the cast-iron projectile, and this projecting 4 inches to the rear carried a lubricant which the wooden wedges at the bottom sent out, while expanding the casing so as to fill the bore.

The casing was perhaps intended also to lessen the play of the shell on turning over from the loading to the bearing side on coming out, but it has been now given up.

All the plans however of centring against the bore are more or less trying to the shells, according as the windage and consequently the play, in turning from the loading to the firing bearing, is greater or less.

The weight of the last projectile employed, is about 44 lbs. and its powder capacity about 4¼ lbs. It is thick in the rear and thin in the front, tapering to a point.

The next plan of centring against the bore is that of Mr. Haddan.

The rifling consists of 3 large and shallow elliptical grooves about one sixth of an inch deep, which take away nearly two-thirds of the surface of the bore. (See Figs. 13 and 14.)

The projectile has three wings on its fore part, which are put on straight with the axis of the shot.

The rear tapers and has a shoulder for a ring wad a, a.

The inventor described its shape as being like that of a skittle pin, but he has lately modified this figure.

The 32-pounder projectile weighs about 52 pounds, and its powder capacity is about 3¼ lbs.

The last plan of "centring against the bore" is that of Mr. Whitworth.

The rifling is called "hexagonal," but there are twelve sides, six wide and six narrow; one portion of the six wide sides is sloped off, which facilitates loading, &c.

The projectile, after being turned to an exact round in the centre, is planed over the portions which correspond to the six flat sides of the grooves.

This planing on six sides of the projectile (which is entirely of iron) leaves it with sharp edges for bearings on which to centre itself in the gun. The projectile is long, tapering at each end, the rear being flat and the front rounded, while the rifle twist is very sharp. (See Figs. 15 and 16.) Of the plans of centring against the bore, the hexagonal gives the least play to the projectile, but, as there is no shoulder to receive the shot on its turning from the loading to the bearing side of the groove, the projectile wedges itself round against the bore, which the sharp edges have a tendency to cut. The effect of this may be seen in the breech loading 80-pounder that cracked at Portsmouth, and was sent back to Woolwich; but with guns of smaller calibre, which are fired with low charges of powder and light shot, the wear is comparatively small. For further information on the subject of giving rotation to the shot, I may refer you to Captain Blakely's paper on "Rifled Ordnance," published in vol. iv. of the Journal of the Institution, page 397.

The Concentric System.

The 4th system, "Concentric," is that which I laid before the Minister of War in 1859, and which was carried out before the close of the year in a 32-pounder service gun and rifle projectiles.

The rifling is called "centrical" from the peculiar mode of centring

its simple iron projectile, which, instead of inclining towards the bottom of the bore in its passage out, is centred on its rounded bearings without jar by the first pressure of the elastic fluid. (See Figs. 19 and 20.)

This is effected by the peculiar curves of the shoulders of the three grooves, which incline towards the centre of the bore, and thus form three rails for the projectile to glide out upon without being compressed or strained.

The projectiles, however much they may vary in diameter from unequal casting, so long as they are not too large to go into the gun, or too small for their bearings to reach the edge of the shoulders, are retained concentric with the bore by the shape of the curves; an advantage that cannot, I believe, be obtained by any other arrangement of grooves. In fact, unless a similarly curved shoulder be adopted, the least variation of size in an iron projectile, must reduce what was perhaps intended for three long bearings, to three mere points. This will be apparent by considering that the outer part of any rifle groove is longer than the inner, and hence, if a curved projectile be planed to a twist, which would correspond to that of a whole turn in twenty feet, its surface curve will be slower than intended, if the projectile be of less diameter than the proper gauge, and sharper than intended, if the projectile be larger.

In neither case would the shot bear against a long line of the (spiral) rifling, and hence would lie across the bore, and be liable to crack, from the twisting action to which it would then be subjected. Practically, it is extremely difficult, if not impossible, to plane or turn an iron projectile so as to fit on a long bearing *against the bore*, for, in proportion to the increase of charge used, the shot will wedge itself further round from the wider or more deeply grooved part of the bore to the narrower or shallower part; in other words, the major axis of the shot, has, in proportion to the increase of powder charge, a greater force driving it more tightly into the minor axis of the piece.

The centrical grooves are three in number, and not over $\frac{1}{5}$th of an inch deep ($\frac{1}{8}$th is sufficient), and about a fourth of the surface of the bore is swept out by the rifling. The shell weighs 38 lbs. empty, and contains 4 lbs. 13 oz. of powder. In the case of firing heavy projectiles from a gun of large calibre, it would be necessary to take out a small piece, so as to form a shallow shoulder for the shot to turn against in loading. (See Fig. A.) Leaving you to compare the methods of rifling of Messrs. B. Britten and Jeffrey, firing compound projectiles, and those of Messrs. Lancaster and Haddan, firing iron shot, as their plans are said to be "competing" with mine, I may perhaps venture, as a gunnery officer, to assert that many of the points which are desirable for a naval weapon are obtained by the concentric system, and these are what I beg you to join me in examining. The first four points laid down in the standard given at page 426 are evidently possessed by this system.

The 5th, "Give a flat trajectory" is also obtained; the mean range of the rifle shell fired at 2 degrees elevation from the common cast-iron service 32-pounder being 1,130 yards, whilst the range of the shell fired from the wrought-iron 100-pounder is only from 910 to 920 yards.

The elevation however is in the first case given by quadrant, in the second by tangent sight.

It is now known that lead-coated shot make a smoother hole than those of iron only, and it is certain that the projections on the latter would increase the splintering effect. Taking a circle over the projections of the 32-pound rifle shell, it is very little smaller in diameter than the iron portion of the 100-pound projectile.

6th point. "Have projectiles that deflect little, and ricochet straight and evenly."

The projectiles are balanced, and are thinner and lighter at the ends, which are rounded when intended for long range or ricochet.

The principal weight being thus in the centre of the shell, and its rounded ends of equal weight, it appears to go point foremost throughout the trajectory, and not appreciably to deflect. The shell also ricochets with tolerable evenness, though always slightly to the right.

The round ball, however, can be used from the gun for this purpose, and especially for hitting the hulls of low gunboats at a long distance on a smooth sea.

7th. "Fire elongated molten iron shells."

For this the system is well adapted; and, as the projectile centres evenly upon its rounded bearings without any dangerous jar, a full powder-charge can be sately used, and long ranges for burning distant arsenals, &c., be obtained.

8th. "Fire elongated powder-shells near or across ships with safety."

Three hundred rounds have been fired from the rifled 32-pounder cast-iron service gun, and about 46 of the 50 elongated shells with which this number of rounds was obtained were re-fired 6 times each (some 7 times), and *were still serviceable.*

As the shell stood this knocking about without a single one getting cracked, it may be fairly inferred that they can be fired over and across friends without the slightest danger.

It is worthy of notice that the rifle grooves showed no trace of wear after 300 rounds, and the great strength of the projectiles is greatly due to the projections or flanges which form their bearings.

9th. "Fire shrapnell or built-up shells over boats with safety." This also can be done.

10th. "Fire canister."

The rifling will discharge these and all the present service ammunition without the slightest danger of being injured, for the outer edge of the shoulder is rounded off, and no possible amount of wear could damage the centring of the elongated projectile.

The value of the grooving for firing round shot has been sufficiently proved at Shoeburyness, where great accuracy was obtained; and, were the bores of new guns left a trifle smaller, they could be rifled on the centrical principle, and without lessening the facility of loading them the round balls would be projected with much greater precision, and also with greater range, than that at present obtained from the smooth-bore gun.

I have now to point out that the simple elongated iron shot is superior to the compound for storeage and carriage, that it does not cost half so much at first, and, while the iron shot can be re-fired for practice, neither the leaded nor the zinc-ribbed shot can.

In a sea-way, a wad would be required to keep the charge from

moving; it is doubtful whether this could be safely used with the shunt, and still more questionable in the case of expanding projectiles, which, by closing the windage, cut off the gas, that, with an iron-shot, would pass by and drive the wad out before it.

The expanding lead shells also are, from the weight of lead affixed to their rear, obliged to have a considerable thickness of iron in front to counter-balance that weight, and a corresponding reduction of thickness at the centre; this makes the shell weak and of less value for breaching.

All leaded shot carry a great weight of lead, merely for the purpose of taking the rifle grooves, and this soft mass is very liable to get out of shape, and to stick in the bore on loading; and, while the lead-coated projectiles are less than the diameter of the bore of the gun, the iron shot have the advantage of the additional width of the projections which extend into the grooves.

As respects the finely-grooved breech-loader, it is clear that the strain of starting the projectile, wedging it through a narrow hole, and again nipping it at the muzzle, must be very great, and that every successive shock must tend to weaken the whole fabric of the gun, as well as to disintegrate the metal of the vent-piece.

It is likewise apparent that the friction caused by forcing the projectile to cut its way out of the gun is so much propelling power lost, and this power is really expended in destroying the gun, which absorbs it.

How, then, it may be asked, can this loss of power be avoided? The answer is, by using an iron shot, and if, as some suppose, hard cast-iron bearings will not answer, there is no difficulty in softening or coating them.

The advantage of breech-loaders is very doubtful, for both the vent-piece and screw, and also the wedge, are liable to get set fast, and the flat surfaces presented by both these stoppers occasion a damaging shock to the breech, more especially at high elevations. This effect is avoided, or ought to be, in the muzzle-loading rifle by chambering the bottom of the bore. Breech-loaders are certainly unfit for exposed situations, and have as yet not given satisfactory results between decks, while the additional metal required in the rear adds considerably to the weight of the gun.

Whatever may be decided respecting breech-loading "per se," it is not to be denied that the leaded compression system, which cannot be used without breech-loading, is the most trying of all systems to the breech apparatus, and it therefore becomes a question whether it is not advisable to give up the plan, for the sake of securing the safety, or at least the longer life, of the gun.

That the fine-grooving itself is not advantageous with large guns has been already in part shown, but the reduction in the projectile's velocity from friction, would be a great drawback to the value of any rifled weapon, and it led to the partial adoption of the shunt-grooving for the navy.

The want of flatness in the trajectory of the 100-pounder shot affords a sufficient proof of this reduction of velocity, but with guns of larger bore the loss would be still more serious.

The fact is, that a soft metal yields too much to give sufficient rotation to a heavy shot, or to prevent its gravitating towards the lower surface of

the bore, and, if the metal coating be made harder, the strain of squeezing it through the bore would be too great for the gun.

The author of the finely-grooved ordnance stated at the C. E. Meeting "That the projectile should rule the gun," and hence, having adopted the built-up segmental shell (patented by Holland in 1854), he had devised "the form of gun most suitable for throwing it." This seems to have been a mistake, for improvements in projectiles are quite as likely to take place as improvements in the cannon which fire them; and by this rule an improved projectile might necessitate a change of gun.

But this built-up projectile is in my opinion inferior, and gives less sure results than those which could be obtained from an elongated shrapnel shell (with a powder charge in the rear), which on bursting would be certain to scatter destruction *in front* as well as at the sides.

It is hardly necessary to mention that there is no practical difficulty in holding any iron shot by studs sufficient to detain it in its place, and prevent the possibility of its sliding too far, in loading from the breech; and such studs could be affixed to the shot, so as to be easily knocked off, in loading from the muzzle.

As to the precision attainable by iron projectiles, this in all plans mainly depends upon the accuracy of fitting, and, were it to be properly carried out, extraordinary perfection would be attained, without at all injuring any of the qualities required by a naval gun.

The adoption of iron shot would likewise admit of the use of what promises to be a formidable means of offence, viz. a flat-headed shot with a powder shell having a percussion fuze in its rear. (See Plate II. fig. B.) Such a shell, if fired from a powerful gun, would penetrate the armour plate and then discharge its mine in the side of an opponent.

But ordnance, as before stated, should be of from eight to ten inches calibre, or more, and, were the present lengths of guns reduced, greater facility of loading would be attained, and thus really powerful rifles of ten inches bore could be constructed, so as not to weigh more than our present sixty-eight pounder cast-iron guns.

Such rifle guns would fire a round ball of 136 lbs. weight (at close quarters), and also an elongated shell of about the same weight, containing nearly 20 lbs. of powder. Such guns would be simple also, and the effect of their projectiles would resemble those of the concentrated broadsides, that future warfare with plated ships will necessitate; and I cannot close these Lectures better than by quoting the words of the preface to the Emperor Napoleon's admirable treatise on the past and present of artillery, where he says:

"Whatever is complicated fails in producing good results in warfare; the promoters of systems forget always that the object of progress ought to be, to obtain the greatest possible effect with the least possible effort and expense."

Friday, June 7th, 1861.

MAJOR-GENERAL THE HONOURABLE JAMES LINDSAY, M.P. in the Chair.

CAMPS OF EXERCISE.

BY COLONEL J. LE COUTEUR, Jersey Militia Staff, A.D.C. to the Queen.

I THINK it proper that an officer who has retired for many years from the active service of the army, should offer some apology for presuming to read a paper on a subject so much more practically known to many, if not to all, who may now be present. From my position as commanding officer of three regiments of militia for above a period of thirty years in the island of Jersey, and subsequently as adjutant-general to the whole force, I have been lead to read much on military subjects, and have reflected deeply, not only on that most important of all considerations the defence of the country, but also on the best method of training troops in camps of exercise.

I was once asked by that accomplished officer, the late Major-General Torrens, whether I thought the camp at Chobham was all that was required for instruction? My reply was to the effect that the highly-distinguished commander, who handled that beautiful force with such consummate skill and ease, seemed to be making it a school for the brigadiers and commanding officers, rather than one for the juniors and soldiery. How so? Troops should be taught to move in order of battle, with every requirement of war,—guides, pontoon train, engineer establishment, military train, camp equipage, commissariat,—to encamp at distant uncertain points, to entrench a position, with a view to its defence against a superior force. General Torrens quite agreed with this view, but added that such expenditure as those movements might require would not yet be tolerated by the country; the money voted for Chobham was already expended, it would be useless to ask for a further supply just now.

Camps of exercise, or camps of instruction, have existed from the earliest periods, under the immediate direction of the Most High. The disposition of the Hebrew encampment was first laid out by the command of God. Cyrus, one of the most favoured of the heathen world, a general among the greatest and wisest, was not only himself trained in a camp of exercise, but he established one more perfect, in which his officers and soldiers were exercised to feats of arms, trained to martial array, and to field movements. The modern institutions of the "Legion d'honneur," or the "Victoria Cross," are imitations of his celebrated band of "alike

honoured." Yet, great as they were in personal merit and warlike accomplishments, he was surpassed by none of the "alike honoured." His consummate discrimination of merit was only equalled by the nobleness and liberality with which he rewarded it.

In a later period, before touching upon the purpose of a modern camp of exercise, it may not be deemed uninteresting to consider shortly to what end the greatest master of the art of war formed camps—whether as temporary camps of resistance, or camps of permanence.

In his first invasion of England, Cæsar landed his five legions, with 2,000 horse, from 800 vessels.

A great army of Britons had been assembled to oppose his landing. Appalled by the vastness of the fleet, they retired to the mountains. Cæsar having landed his army, chose a safe site for his camp, left a force to entrench it, and then marched against the enemy. The following morning, having forced the weakly barricaded camp of the Britons, he found the position well chosen, and immediately resolved to fortify it for his own army. The next morning, intelligence having been conveyed to him that a dreadful storm had caused infinite damage to his fleet, he returned and drew all his remaining ships within the fortifications of the camp. Ten days were employed in this duty, during which the soldiers had *no intermission of fatigue*, not even during night, until the camp was securely fortified.

From this camp Cæsar sent out foraging parties, and, although these and the camp itself were repeatedly attacked with extraordinary valour by the British, the camp remained impregnable.

From that base of his operations Cæsar conquered the Britons. As the period of the equinox drew nigh, taking advantage of an extraordinary calm, he suddenly re-embarked his army, with a great body of prisoners, set sail about ten o'clock at night, and by day-break brought his whole fleet safe to the continent of Gaul. In this instance he insured a constant supply of stores for the repair of his fleet, as well as rations for his men, by being master of the Channel.

On another occasion, Cæsar, having planned an excursion towards the Scheldt against Ambiorix, sent all the baggage of his army to Attualica, a castle and camp which he had strongly fortified the previous year. Quintus Tullius Cicero, with the fourteenth legion and 200 horse, was left in its command. Cæsar was to be absent only seven days, during which he had enjoined Cicero to allow no one to quit the camp. On the seventh day, the men, becoming weary of confinement within the camp, were urgent to quit it; Cicero weakly yielded; sent half his force, or five cohorts, with carts and camp followers to forage. At this very moment a body of 2,000 horsemen of the Sicambri, who had been urged to attack the Roman camp, on being assured of its defenceless condition, and the absence of Cæsar with his army, suddenly attempted to force the entrance of the camp. The cohort on guard could scarcely withstand the attack. A centurion of the first rank, who was among the sick in garrison, rushed, though incompletely armed, to the assistance of the guard, and, although he bravely sacrificed his life, the post was maintained, and some confidence was restored; meanwhile the foragers returning, assaulted the enemy, who after much loss were driven off, and the camp was saved. In this in-

stance the prudence and foresight of the great commander were nearly set at nought by the imprudent weakness of Cicero, in yielding to the wishes of his men, and disobedience of orders. Cæsar, on returning, only complained of the sending out the cohorts to forage, observing, "That in war nothing ought to be left to fortune, whose power appeared evidently in the sudden arrival of the enemy, and much more in their coming up unperceived to the very gates of the camp." Few armies have ever been better trained than the Roman. Their system can be applied with advantage to any army.

Recruits for the Roman armies were selected from country labourers, as should be the case with our own, rather than from the population of towns; field labourers being more simple in manner, and hardy of frame. In their training, the practice was rigorous, methodical, and exact.

The recruit was furnished with an osier shield and a wooden club, each of them double the weight of the military shield and sword; with these he was trained twice in the day in attack and defence, and especially taught to give point: the manual of the javelin, and the shooting with arrows was taught scientifically, as the use of the rifle is to be now. When the soldier was deemed perfect in his elementary drill, he was taught evolutions and complex movements, to open or close ranks, to form square with celerity, and from square to form into the triangle or wedge, to move in these formations and in a hollow circle. Thrice in a month, fully accoutred and armed at all points, carrying *sixty* pounds weight of kit, the Roman soldiers marched four thousand paces, or above a two-hours' march from the camp, at times on a plain, at others over broken ground. The centurion was not only selected for his skill and prowess in the use of arms, but he was to be sober, vigilant, and active, more prompt to act than to speak, zealous to maintain his company in discipline, to see that it was suitably clothed, and well provided with *good shoes*. It is not a little remarkable, that the forecast of a savings bank was to be found in the stock purse for every cohort, and a general purse for the whole legion. Although in common, it had the same tendency as a savings bank to create a local *attachment* to the service.

During the decadence of the Roman state, the whole scene was corrupt; morals were licentious, and civil liberty drifted into slavery.

From the moment the Romans became enslaved, their armies felt the stain, and their discipline and conquests fell together.

Ancient traditions taught the Franks to claim the Romans as their kinsmen; yet, in the mediæval ages which followed the fall of the Roman empire, very little, if any, of that exact and stern discipline, which had been the soul of its armies, was retained. The barbaric sovereigns of Britain and of Gaul adopted the Roman insignia and imagery for the assertion and demonstration of their authority, but the trappings did not constitute the force.

It is after a lapse of seventeen centuries, that the armies of Britain and of Gaul have returned to that stern and steady discipline which have rendered them, combined, as renowned as the tenth legion of Cæsar, and as irresistible!

During a long period, which may strictly be called the feudal days, or those of chivalry, training to arms belonged rather to the feudal lords

and their immediate retainers, archers, or men-at-arms, than to great armies, or the people at large.

The invention of gunpowder, its application to the purposes of war, and the use of firearms and artillery rapidly revived strategy and tactics. In the fourteenth or the fifteenth century, though there may not have existed camps of exercise, yet the training of troops must have become pretty general, for the Emperor of the French, in his "Past and Future of Artillery," states that the best infantry of that period, the English archers, the Swiss and the Lansquenets, were mostly without defensive armour. *The English archers at Agincourt*, according to an eye-witness, Le Fevre de St. Remy, were without armour, and barefooted. Louis the Eleventh of France established an entrenched camp two leagues in length, in which to instruct his troops. These troops, says Philip de Commines, were composed of mounted men-at-arms of his free companies, trained to alight when necessary, with an artillery, which could be easily transported where wanted, and a great number of carts and chains.

At so early a period as 1476, the Swiss must have been carefully trained in camps of exercise.

They were formed in heavy battalions in solid squares with as much front as depth, composed of artillerymen (coulevriniers), halberdiers, and pikemen in varied proportions. The artillerymen were either placed in front, or on the flanks of the battalion. The pikes destined to resist cavalry were firmly fixed on the ground. The halberts, much shorter, were of signal use when the *melée* took place. Their army, according to the usage of the period, was formed in three corps; but instead of moving in rear of one another, or in column, they moved *en échellon*, the centre corps marching straight on the foe, while the two others attacked his flanks. Their artillery, composed of light guns, was placed within the intervals of infantry. To protect the guns, and to clear the line of march, they had musketeers, who acted as skirmishers, and were named the forlorn hope (*enfants perdus*).

They feared no cavalry, as this could not break their ranks; and as to artillery, which alone could furrow their compact masses, this, owing to its discharge being slow, gave little cause for alarm. Firm to receive its first fire, they rushed on the guns, in order that they might seize and turn them on the enemy. Sentence of death was passed on any who should quit his ranks. No cries were allowed, but a deadly silence enforced. With tactics, however, valour has changed its nature, coolness and compact order have replaced headlong bravery and single combat. These troops were found to be invincible, and Louis the Eleventh took six thousand of them into his service. On these he re-organised the French army, leaving, writes a contemporary, three treasures to his successor, a standing army of 60,000 men, a marvellous train of artillery, such as had never been seen, and all his frontier towns well fortified.

About the early part of the seventeenth century, or 1610, Prince Maurice of Nassau introduced a new system of manœuvre, quite different from the very deep and square columns or lines which had prevailed. He formed his battalions of 500 men, ten deep, and his squadrons, from 100 to 200, five deep. These enabled them to form from columns into lines with greater celerity. The Emperor of the French gives the credit of

having rendered armies more flexible, and of having introduced a new order of battle, to him rather than to Henry the Fourth and his immortalised minister Sully.

The northern Cæsar, Gustavus Adolphus, may be said to have taken the hint from Maurice of Nassau, but his mighty and inventive genius stepped at once from the unwieldly and inconvenient depths of order of battle to what may be called Dundas' tactics. In his camp of exercise he formed his regiments into companies, sections, and sub-divisions (Corporalschafften), each having a chief file and coverer, so that every private, without appeal to his officers, knew his place. Each company was composed of 72 musketeers and 54 pikemen; eight companies formed a corps of 1008 men, and two regiments a brigade. The king had seen that, with the old deep formations, the rear ranks were thrown into disorder by the front ranks, especially when a heavy fire from artillery mowed down whole ranks. Gustavus formed his regiments in six ranks while moving, and three deep in order of battle. The front rank kneeling, the second stooping, the third erect. The pikemen were distributed so as to receive cavalry. Guns were attached to the regiments, so that each brigade was a moveable fortress. The wonderful success which attended his arms, prove the sagacity and greatness of his designs. He abandoned the system of forlorn hopes, or tirailleurs, because he deemed that battles were to be won by masses, not by skirmishers. Chemnitz states, "No one equalled him in leading an army to battle, in covering a retreat without loss; or in encamping in security in the open field by rapidly covering it with entrenchments. It was impossible more perfectly to understand fortification, attack, and defence!"

To severe discipline he added most liberal and impartial justice. Favour was unknown. No one could rise but by merit. He partook in hardships with his soldiers, and in camp slept in the open air when they did so.

The tactics of Gustavus Adolphus form an era in war! Camps of instruction were instituted by Louis XIV. of France, and although no great changes were introduced in the movements of infantry by that monarch, the greatest honour belongs to Vauban for his improvements in the science of defence and attack, in a word, of Fortification!

In 1778, forty battalions and 20 squadrons, with 40 guns, were formed into a camp of instruction at Vausseiux, under Marshal Broglie, besides a smaller force of ten battalions and nine squadrons in a camp at Paramé. Here the vexed questions between the older system of manœuvre and that introduced by the great Frederick were canvassed and worked out by the manœuvres then carried on. The true relative value of the two systems was appreciated. It was seen that neither was absolute or exclusive—that the variety of movements and the operations of war require the employment of various modes of formation and deployment; that consequently troops act best in those movements which are admitted to be the most simple and prompt, leaving it to the *coup-d'œil* of the general to choose on the field of manœuvre or battle such as the circumstances of the moment should make preferable. A later writer, after some critical remarks on the disastrous conclusion of the war with the Anglo-American States, after tendering his admiration of the English constitution and government in high terms of praise, proceeds to offer warnings, which are not more out of season now than they were then: "While all the nations of Europe are

occupied in perfecting their tactics, England remains the only power which holds to old principles, although she should be among the first to seek how to perfect this art. The English conquered formerly because the armies opposed to them followed the same order of battle. Justice must be done to the English people, and whenever bravery is in question, they yield to none; but in these days bravery in battle does not determine victory; it is decided by skilful manœuvres, a rigid discipline, a blind obedience to officers in command. The days of the Edwards are bygone. Great Britain has neglected to profit by the leisure which a time of peace afforded her to organise a militia, which should be equal to her defence if she were attacked in her homesteads. She has carried all her attention to her Navy; but what would befall her if France really effected a descent upon her soil? Can she flatter herself that she will be in a position to prevent it with an undisciplined militia, armed citizens, or labourers? What effect would such defenders of the nation have against 40,000 select troops, brave, trained to war, disciplined, and commanded by intelligent leaders?" After these ominous words of caution, and an entirely mistaken view of the discord which politics might be supposed to create, he continues: "The English have been persuaded that their maritime power would suffice to secure them from any incursion on the part of France; that they had to fear no such revolutions as were caused by William the Conqueror, and William of Nassau; but, neighbours as they are to France, knowing her power, her wealth, the resources which she can create, how is it that they have not calculated that she may, *when she pleases*, think seriously of *creating a navy, make it as formidable as that of England, by means of which to land*—if wanted—200,000 men on her shore." (1780.)

In a note, it is observed: "It is in London itself that it must be sought to vanquish our vain-glorious rivals, and not elsewhere." "This expedition, prepared and carried out with the greatest promptitude, is the only one which might disconcert the measures of the Cabinet of St. James."

In the short space of a quarter of a century, the Emperor of the French has accomplished the prophecy. France, when it suited her policy, has created the fleet we saw at Cherbourg—the iron-plated gunboats, and a body of seamen such as no fleet but that of England possesses; in addition to a finer composed army than she ever before displayed.

The great Duke of Wellington and Lord Overstone have, with military and statistical authority, shown the frightful consequences which a hostile march on London would entail, not alone on the nation but on the world at large: the fall of Nineveh would be as a feather in the world's balance to such a calamity. The Volunteers of Britain have been aroused, gloriously, by the mere forecast of the shadow. Vattel foresaw this grand movement of our Volunteers, in his laudation of England. "An admirable constitution there places every citizen in a situation that enables him to contribute to this great end, and everywhere diffuses a spirit of true patriotism, which is zealously employed for the public welfare. Happy constitution! which they did not suddenly obtain; it has cost rivers of blood; but they have not purchased it too dear. May luxury—that pest so fatal to the manly and patriotic virtues, that minister of corruption so dangerous to liberty—never overthrow a monument that does so much honour to human nature—a monument capable of teaching kings how

glorious it is to rule over a free people." True and happy as this opinion may be, nevertheless to the Volunteers alone, interests so mighty may not be entrusted. The former French writer goes on to ask, "What forces has this power (England) to oppose to her rival?" I repeat it—shall it be by citizens armed in haste, without discipline, without tactics, that she will oppose a formidable army, brave and highly disciplined? Notwithstanding the fine state of discipline of the French army, its late military writers complain that colonels have introduced into their regiments new systems, deviations from regulations, which were irksome to learn. Men were taught to move with extraordinary alertness—to fire with great rapidity; and received great praise for what never can be turned to account in a field of battle: another officer might assume the command of the same corps, with an entirely different system, when the officers and men would have to unlearn in part and learn afresh in part. Is this complaint confined to the French army? That incomparable soldier, either for covering an advance or a retreat, a great though not a faultless tactician, Marshal Ney, remarks—"Most of the infantry manœuvres executed in time of peace are not used in war; those easiest to be understood ought to form the basis of manœuvring, and their execution should be rigorously enforced. The superfluous must be rejected without hesitation; and the leisure of winter-quarters, now spent in teaching useless evolutions, which the troops will scarcely ever have to perform, even in the course of numerous campaigns, be devoted to instructing the infantry officers and non-commissioned officers.

"They should be taught the system of attacking and defending fortified places; they should be exercised in the erection of military field-works; in attacking and defending a post; in military reconnoitring, &c.; and lastly, their *coup-d'œil* must be exercised in the choice of positions and encampments, whether for offensive or defensive operations."

It is in this view that it is asked, how camps of exercise should be constituted, so as to form an army, not only for field movement, to captivate the eye, but for absolute practical, habitual, work of war?

The system might commence at the Royal Military Colleges, where, in addition to the usual instruction, studies and practical instruction for field-works, we would apportion two half days in the week for instruction in regimental and brigade drill. When the superior under officers of companies became thoroughly equal to command their respective companies as battalions—by rope-drill—they should be further instructed in brigade rope drill. When conversant with this, the companies should act as battalions, and in brigade perform all the simple movements of great bodies necessary for service in the field. Other parties with descriptive flags, and with ropes, might take space for and represent cavalry and artillery.

Such exercise would tend to health, be an instructive amusement, and impart to an intelligent youth a feeling of confidence in the knowledge of his profession. With such a course, and occasional lectures to explain how some of such movements have been applied to fields of victory or why battles were lost, not only would the knowledge of handling troops be gained, but the object or meaning of such and such a movement would be

plainly apparent. Cadets so instructed might join their corps almost prepared for the field, while they would probably take a more lively interest in acquiring the peculiar after knowledge needful to fit them for ultimate command.

In a camp of exercise it would be proposed to divide the instruction into regularly established courses; for instance,—

MONDAY.—*In fine weather.*—Squad, company, and regimental drills.

In foul weather.—Assembly of officers in a hall of instruction, for *vivâ voce* examination by the majors or captains in turn.

The men to be kept up in aiming drill, the recruits and defaulters at shed drill. As in the Russian army, the men to be encouraged to learn sewing, for the repair of their clothes, shoemaking, or any trade which might conveniently be taught in a permanent camp of instruction, and which on discharge might enable them to add by their industry something to their pension. No better member of society can be met with than a sober, industrious soldier or sailor who settles down to his trade or calling.

TUESDAY.—*In fine weather.*—Brigade drills for more instruction, under the eye of the brigadier, in which any commanding officer should be called out to assume the command of the brigade, under the supposition that the brigadier is *hors de combat*, or disabled.

In foul weather.—A lecture, presided over by the brigadier, to be prepared by a selected officer from the staff or a battalion, on the principles of the secure march of armed parties through the country of an enemy; reconnoitring to be effected in an open or a wooded country, either with, or without cavalry or artillery.

The nature and duties of advanced, rear, and flank guards to a division, or to an army on its march.

The safety of the land transport train, its effectual security by peculiar instant formation in case of sudden attack.

On the manner of giving commands, and the execution of evolutions and grand movements.

On the attack and defence of posts and of fortified places.

By Officers of the Artillery or Engineers.—On the attack and defence of posts and of fortified places; on the powers of artillery; on field fortification, roadmaking.

By Officers of the Commissariat.—On the provisioning of armies; the most perfect mode of contracts.

By Officers of the Military Train.—On the most perfect means of transport; the difficulties to be surmounted in the country of an enemy; the best mode for its own defence from attack.

By Officers of the Medical Department.—The best choice of a camp; best means of keeping an army in health; food; clothing; drainage; sanitary suggestions to officers on detachment when far from a medical officer.

In a word, each to convey the best instruction in his power to all.

WEDNESDAY, A.M.—Movements by divisions of all arms: artillery, cavalry, infantry, military train, for more instruction by the commanding general; siege operations.—P.M. Repose.

THURSDAY.—Repose; cleaning arms; drying, cleaning, and repairing clothes.

FRIDAY.—*Grand movements.*—It is supposed that the camp of instruction may consist of 30,000 infantry, 6,000 cavalry, 60 guns, with 1,050 artillery, and 900 horses, and about 2,250 horses for officers.

N.B. Eighteen hundred men and 3,600 horses might be required in a hostile country for the military train or transport of provisions, forage, spare ammunition, camp equipage and ambulance of such an army advancing to meet an enemy, with requirements for three days.

Of these it is supposed the first division is ordered to march as a corps of observation, with provisions for three days.

It is composed of 10,000 infantry—four brigades of three battalions; 2,000 cavalry—four regiments; 20 guns, with 350 artillerymen and 300 horses; 750 horses for officers; 600 men, and 1,200 horses for the field, train, and supplies; the supply for three days for this force would stand thus:—

		Casks.	Weight.		Remarks.
			lbs.	lbs.	
Daily.	12,950 rations of biscuit, 1 lb...	...	12,950	12,950	
	12,950 „ „ meat, 1 lb...	...	...	...	in live cattle.
	12,950 „ „ spirits, ¼ pint	90	6,475	...	„
	4,250 „ „ corn, 10 lb...	...	42,500	...	„
	4,250 „ hay or straw, 12 lb.	...	57,000		„
	Fuel	..	...	55,000	
	Total		112,925	Weight of	one day's consumption, exclusive of meat and fuel.
			3		
			338,775	Weight for	three days.

Required for conveyance of Provisions and Forage,		182	four-horse waggons + ½ =		243
„	„ Spare Ammunition	20	„	„	20
„	„ Camp Equipage, &c.	20	„	„	20
„	„ Ambulance, &c.	17	„	„	17
			Total ...	...	300

General observations.—This statement does not include the transport which may be occasionally required for carrying out the rations to the troops when occupying dispersed cantonments, or an extended bivouac, nor for the procuring of fuel; nor has any allowance been made for non-effective animals from casualties.

The number of waggons will generally be found sufficient, admitting always that the magazines are within six or eight leagues of the troops; for the transport so employed, without any general resting days, will seldom perform more than 10 or 12 miles a day when loaded, and about 15 when unloaded; and assuming the magazines to be 24 miles from the camp or cantonments, the waggons are reckoned to take four days in going

to and fro, including the time consumed in receiving their loads. No allowance has been made for unavoidable waste, losses from weather, leakage of liquids, &c., but on the other hand it must be inferred and admitted that hay and straw, or green forage may generally be looked for near the bivouac or cantonment—therefore one may be placed as a set off against the other—whilst it might at the same time meet the contingencies alluded to in the first paragraph of these observations.

The spare small arm ammunition is calculated at 360,000 rounds in addition to the 60 carried by the soldier; the transport, however, for this must be regulated, in some measure, by what the artillery may have the means of conveyance for by their carriages. The transport for the camp equipage and ambulances can only be considered as an approximation under ordinary circumstances. With us it has always been the custom to allow each subaltern of infantry forage for one horse or mule, captains two, field officers three, and officer commanding a regiment of infantry four; which therefore are included in the estimate.

A waggon, according to the state of the roads, is reckoned to convey from 1,700 to 2,000 lbs.; if mules were employed, a single mule from 150 to 180 lbs.; ten mules being assumed equal to one waggon, or 3,000 mules to 300 waggons.

The transport, immediately attached to the troops, should consist of the regular military train; but the other would be probably auxiliary, and hired in the vicinity of the operations according to circumstances. No army ought to move without its own permanent military train to the extent provided for in the estimate, with a reserve for casualties; and, had our troops on the late expedition (to the Crimea) been so provided, the probability is, that a great portion of their sufferings and privations would have been obviated.

Under the supposition that the enemy's country afforded no means of subsistance, reserves of everything requisite to meet the consumption for the probable period the operations would last, must be formed at the starting point or base.

So long as the army operates within a radius of from 24 to 30 miles, the transport stated would suffice to maintain the supply; but in the event of advancing another 30 miles, then an intermediate depôt would have to be formed at the termination of the first 30 miles, from whence the transport with the army would proceed to load up. This intermediate depôt would be supplied from the grand reserve at the base, and would require about 240 additional waggons (an auxiliary description locally formed would answer), and so on in proportion to the augmentation of the distance from the grand reserve, always assuming the country to be entirely destitute of provisions and forage.

It is with a deep feeling of gratitude, that the above valuable memorandum is acknowledged to have come from that highly distinguished officer the late Commissary General Sir George Maclean.

It would seem, from the information thus afforded by an officer of the greatest experience, to be of the very highest importance that commissariat officers should be employed at all our garrison stations, in order to enable them to acquire that knowledge which would be for the public interest whenever their services should be required, either for provisioning bodies of

troops at home, or for service in the field. In what other manner are young men to learn the price and quality of provisions, the cost of transport, and all the requirements of bodies of troops, except at enormous cost to the public?

If some innovation in the usual mode of conducting grand reviews is now proposed, it is from a hint by Marshal Suchet, one of the most able of Napoleon's generals. He remarks that, in reviews, movements are performed with uniform regularity; if anything goes wrong, it is soon set to rights by the general commanding, or some of his staff; there is nothing to disturb his composure but the unpleasantness of exhibiting mistakes.

Far different is it on the field of combat, where the confusion, the turmoil of battle, smoke, noises, death, and destruction, in various forms, wounds and cries of anguish, the loss of commanders of tried skill and valour, a corps in part annihilated, guns taken, combine to perplex and confuse; when all these disasters fail to disturb the man, or to deprive him of a cool penetrating glance, or to prevent him from affording aid and support wherever wanted, with the promptness and precision of a field day—such a man is truly a great general. Might not some training towards such a result be possible and useful? We will now suppose the first division, composed as above, ordered to march into a hostile country as a corps of observation, with provisions for three days as enumerated. It marches in column of divisions right in front with videttes, an advanced guard, flank guards, the cavalry, artillery, and field train in succession, and with a rear guard. We will further suppose that the division has advanced into the hostile country a day and a half unexpectedly. The advanced vidette suddenly perceives the enemy, and halts concealed. A staff officer flies to the rear, reports to the general commanding that a force of the enemy, from 10 to 15,000 men, with eight guns, and a body of cavalry is in view, and halted at dinner.

The general gallops to the front, dismounts, and from the brow of a hill observes the enemy; his left flank resting about one mile distant, under direct enfilade from the point of observation. He orders the most complete silence to be kept; the troops to march up with trailed arms; the first brigade to take its left shoulder forward under cover of the hill; and when its rear has passed the flank of the enemy to wheel to its left into line, and advance in direct *échellon* to attack by battalions from the right: the second brigade to form in like manner, and march in support of the attack: twelve guns to be placed so as to enfilade the line of the enemy, and disturb his formations: one regiment of cavalry to be in support of the guns: one regiment of cavalry and four guns to cover the right of the first brigade.

The third brigade, with one battalion of the fourth brigade, in double columns of battalions at quarter distance, one regiment of cavalry, and four guns, is ordered to form the second line.

Two battalions of the fourth brigade, with a regiment of cavalry, and four guns, are to form the reserve.

One battalion of the fourth brigade is to guard the field train.

The enemy, surprised and vigorously attacked, has his left wing rolled up, but makes a skilful defence with his right wing.

A staff officer announces that the commander of the first brigade is killed, (six guns having opened upon it, supported by tirailleurs,) the captains of Nos. 1, 5, and 7—sections 3 and 5 of those companies, are also

killed or wounded; as also files 7, 9, 16, 21 of companies 3, 4, 6, 8. The senior subaltern and covering sergeant of those companies are also wounded. One man only is to fall out to assist a wounded man to the rear. The nominally killed and wounded are instantly to repair to and form in rear of the centre sergeants of battalions.

The general-in-chief whilst directing the attack is killed.

An aide-de-camp reports the disaster to the second in command.

The first line, requiring support, is reinforced by the second line.

The cavalry charge the broken wing of the enemy.

The colonel who commanded it is reported killed, with a considerable loss of officers and men.

The captain of the first battery is reported killed, and two of the guns disabled.

Four guns from the second line are ordered to the support of the first battery.

As each successive casualty is supposed to occur, the adjutant of each corps will call out the numbers of killed or wounded, who will immediately fall out, thus the troops will be taught how to close up gaps in their ranks during action, how to remedy disorder, and how officers quite unexpectedly may be called upon to exercise command and judgment.

It is believed that by some such teaching young men of ardour, with a natural genius for war and command, might more or less frequently exhibit qualifications now lying dormant.

This instructory disorganisation, if applied to every arm, might prepare each to meet real difficulties with such resources as can only best be called forth by a ready and previously prepared mind. The confusion might at the outset seem to be inconvenient, but the teaching and knowledge gained might prove invaluable on a day of battle.

The great Napoleon shows how even his very ablest marshals required teaching: Probably no better explanation of the meaning of the words "*en main*," "in hand," has ever been given than by that great instructor.

On the 16th of June, 1815, at a quarter past three, Napoleon gave orders for Marshal Ney to manœuvre, so as to envelope "the right of the enemy, and to fall at arm's length on his rear. That army is lost if you act vigorously; the fate of France is in your hands." The following day, the 17th, after describing to Marshal Ney the victory gained over the Prussian army, it is stated, "the Emperor goes to the Mill of Bry, on the main road from Namur to Quatrebras; it is therefore impossible that the English army can act in your front; if such were the case, the Emperor would march directly upon it by Quatrebras, while you would attack it in front with your divisions, which must now be united, and that army would be instantly destroyed. Therefore, inform His Majesty of the exact position of your divisions, and of all that passes before you. The Emperor has seen with sorrow that you did not unite your divisions yesterday; they acted unconnectedly, hence you suffered losses. If the corps of Counts d'Erlon and Reille had been united, not an Englishman would have escaped from the corps which came to attack you.

"If the Count d'Erlon had executed the movement on St. Amand which the Emperor had ordered, the Prussian army would have been totally destroyed, and we should probably have made thirty thousand

prisoners. The corps of Generals Gerard, Vandamme, and the Imperial Guard were all along united.

"You are exposed to reverses when detachments are compromised.

"The Emperor hopes and desires that your seven divisions of infantry and the cavalry shall be well united and formed, and that together they may not occupy one league of ground, in order to have them well in *your hand*, and to employ them when wanted."

Here is a plain meaning, 46,000 men within three miles of space are "in hand."

Had Marshal Ney attacked the British at "Quatre Bras" with both corps, instead of with Reille's only—18,000 men,—it certainly might have been a serious affair for the Allies.

FRIDAY.—On intermediate days. Brigade instruction. This duty to be taken by regular roster.

A brigade to march in order of battle, complete in all arms, with Engineers and Field Train. On arriving at previously selected ground, the troops to be halted to encamp. One battalion to pile arms after having placed camp guards.

The second battalion to detach picquets and outposts in such directions as effectually to guard the camp, and protect it from insult.

The third battalion, in fatigue jackets, to proceed with the chief engineer to construct lines of defence, or such field-works as might, by a preconcerted plan, eventually tend to aid in the defence of an approach to the Capital. For this purpose every description of tools should be ready at hand. And if it be true that by one man one cubic yard, or twenty-seven cubic feet of earth, may be dug out in one hour, in the teaching of such for two hours at most, a large amount of useful labour might be gained, for the general defence of the country. In this way moreover the qualifications of the men might become known to their officers, and (in the division of labour) labourers, used to the spade and pickaxe, set to a suitable work; carpenters to their own branch, or to making gabions, fascines, or palisades; those unacquainted with the use of tools, to wheeling or collecting materials: all under the direction of the engineer department, and pioneers of battalions.

After a training of two hours, the brigade to be re-assembled and marched to camp. Each battalion of the whole force being thus, in turn, instructed in field works.

Premiums, or prizes, to be given to those companies and battalions, whose work should be pronounced by the chief engineer to be the best.

SATURDAY.—Grand guard mounting. March past the commanding general, with the whole force, all the bands of each brigade united. Camp duties. Repose.

SUNDAY.—Parade for divine service.

MUSKETRY INSTRUCTION FOR THE CAVALRY CARBINE AND PISTOL,

RECENTLY ISSUED TO THE FRENCH CAVALRY; WITH SUGGESTIONS FOR THE TRAINING OF CAVALRY, AND ITS IMPORTANT FUNCTION IN FUTURE BATTLES.

"The Cavalry is the illuminating torch and the protecting shield of armies."

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PART I. THE SYSTEM DETAILED. *Introduction.*—The French cavalry consists of twelve regiments of reserve, composed of two regiments of Carabiniers and ten companies of Cuirassiers; twenty regiments of Cavalry of the Line, composed of twelve regiments of Dragoons and eight regiments of Lancers; twenty-three regiments of Light Cavalry, composed of twelve regiments of Chasseurs, eight regiments of Hussards, and three regiments of Chasseurs d'Afrique; three regiments of Spahis; ten companies of Cavaliers de Remonte (new horses). There are besides regiments of cavalry forming part of the Imperial Guard; namely, one squadron of Gendarmerie, two regiments of Cuirassiers, one of Dragoons, one of Lancers, one of Chasseurs, and one of Guides, forming the cavalry division of the Guards.

The great Imperial School of Cavalry is at Saumur. Its object is to train instructors destined to teach in the various troops of cavalry a uniform system of equitation and give other instruction appertaining to cavalry. The course lasts one year.*

All the French cavalry carbines are at present rifled; but there are numerous patterns, most of them being "transformations," old arms fashioned into modern requirements. The barrel of their several cavalry carbines is about 35 inches long, the weight of the carbine (called *fusil de dragon* and *carabine de cavalerie* respectively) varies from about 9 lbs. 8 oz. (that of the *cavalerie*) to about 6 lbs. 11 oz. (that of some of the Dragoons). The cartridge is that of the Line, the bullet weighing 480 grains.

Unquestionably the cavalry carbine may be made the most efficient rifle in the service. In this arm we are not compelled to conform to anything like the length of barrel, so manifestly detrimental to accuracy, penetration, and range. Experiments have proved that the utmost length of any rifle need not exceed twenty-eight or thirty diameters of the bore. All beyond this must cause increase of friction, waste of force, and the chance of accidental deviations.

But it is not mere shortness that is required. The diminished length must in other respects be adequately compensated, and nothing is easier, if

* Annuaire Militaire pour l'année 1861.

we bear in mind all the requirements of a perfect rifle, and devise its elements accordingly.

The new French project of musketry instruction for the cavalry * is not intended to lead to any radical change—such as the employment of a "mixed cavalry"—having the double character of a troop of horse and foot soldiers. The principles on which the organisation of cavalry is founded remain unalterable. The only object is to enhance its power, to increase its efficiency as cavalry.†

For if it be essential that the cavalry should know how to manage their horses at all their rates of movement, it is equally important to complete their training as soldiers, by teaching them how to handle their carbine and pistol with skill and precision.

Before the African war the utility of fire-arms in the hands of the cavalry might be doubted; but the experience of the last thirty years has changed our ideas on this subject, and the officers who served in the Algerian war have acknowledged that fire-arms in the hands of cavalry were not restricted, as some pretended, to the office of signalising the approach of the enemy.

It is not supposed that cavalry skirmishers, whatever proficiency they may acquire, can ever rival those of the infantry. The conditions of the fight are too dissimilar to admit of such an idea; but, between skirmishers of the same arm, the advantage will always be with those who by progressive practice shall acquire the greatest proficiency in the use of the rifle.

Such is the object of the French authorities in the following method of Musketry Instruction for the Cavalry, ordered to be first tried at the Cavalry School of Saumur, and then in all the regiments of cavalry.

The adoption of rifled arms for mounted troops infers an important necessity; it would be useless and absurd to place an improved weapon in hands unable to use it to the best advantage.

There will always be peculiar difficulties to overcome by the cavalry soldier in applying the rules of musketry; and the difficulty of habituating his horse to the report of the rifle is not the least. His firing, therefore, strictly depends upon his individual exertion, and it becomes the complement of his training.

The utmost moderation is recommended in the strictly progressive system of instruction. Too much haste would compromise the intended result.

When the horse is made obedient, or, rather, when he becomes obedient by rational treatment; when the report of the rifle no longer startles him; when the rider has acquired the habit of aiming and firing, without altering his regulated position, and without losing his firm seat in the saddle, then will be the time to give him ball-cartridge: for only then will he be able to comply with all the necessary conditions of good firing.

* *Projet d'Instruction sur le Tir du Fusil et du Pistolet à l'usage des Troupes à cheval*, Jan. 1861.

† Nevertheless Gen. Bonneau du Martray emphatically avers, that "it is particularly the tactics of the cavalry that the improvements of the rifle will radically change. Just as the invention of gunpowder modified the ideas of the knights of old in the method of fighting, so will the new projectiles destroy those principles rooted in the minds of modern cavaliers since the time of Frederic the Great. We are persuaded that the latter will become mounted Fusiliers. They should rejoice and take pride in this prospect, which will furnish them with more numerous occasions of being useful, with an increase in the sphere of their activity."

Officers must bear in mind, not only the aim and object of this training, but also the difficulties to be surmounted.

I. THE BASES OF MUSKETRY INSTRUCTION FOR CAVALRY.—The object of this instruction is to teach the cavalry all the resources of their arm, and enable them gradually to use it to the best advantage. It must also be considered as an essential part of their military acquirements, for it developes their capabilities on horseback, by requiring them to be perfect masters of their horses, and gives exercise to their dexterity, by making them handle their arm at the different paces of the horse. It demands, therefore, all the solicitude required in the other parts of the service, and is placed, in each regiment, under the direction of the colonel, who is responsible for its application. The particular direction is confided to the lieutenant-colonel.

As the instruction of the regiment cannot be insured without a competent knowledge in the officers and non-commissioned officers, the course of instruction is first given to the lieutenants and sub-lieutenants* by the captain instructor, and to the non-commissioned officers by a lieutenant.

All the officers should be able to give musketry instruction.

In each squadron an officer, appointed by the lieutenant-colonel, on the recommendation of the captain-commandant, is charged with the superintendence of this instruction.

An officer with the rank of lieutenant, or sub-lieutenant, is charged with the theoretical instruction of a few of the most intelligent corporals. The officer-instructor applies himself particularly to the training of at least one non-commissioned officer and two lance-corporals in each squadron, to assist the officer appointed for the instruction of the regiment. The captain-instructor is charged with the complete training of the recruits throughout the course.

There must be a course of musketry instruction every year. The theoretical and practical instruction of the officers, and non-commissioned officers, must always precede the ball-practice of the squadrons. The colonels regulate the times and number of these instructions.

The course of musketry instruction is the model of our system as it appears in our manual, and therefore it need not here be given. I shall therefore merely quote such parts as are peculiar to the French. The French infantry of the line, and the cavalry, are taught to use the thumb in the absence of the elevating backsight. The method is as follows:—

With the *fusil de Dragon* we can, up to 270 metres, about 293 yards, select such a point on the human body, that, by directing the line of sight upon it, we can bring the trajectory on the waist; but, beyond that distance (nearly 300 yards), we can no longer use the natural line of sight of the carbine. We must use an artificial line, which will produce a greater angle of sight, and, consequently, a greater range of the point-blank. This artificial line is obtained by using the thumb as a back-sight.

The following rules will be observed:—

1°. At 100 metres, about 108 yards, aim at the feet.

2°. At 200 metres, about 216 yards, aim at the waist.

3°. At 250 metres, about 270 yards, aim at the head.

* In the French cavalry there are first and second captains, first and second lieutenants, and sub-lieutenants (*sous-lieutenants*).

For all the distances at which the thumb is used as a back-sight the left hand is constantly placed at the height of the lower band.*

The following rules fix the position of the thumb, in order that the point-blank of the piece should successively correspond to the various distances of the firing.

At 400 metres, about 432 yards, the thumb being bent on the lower band, aim at the waist.

At 600 metres, about 650 yards, the thumb being erect, the joint a little above the top of the lower band (about ¼ inch), aim at the waist.

Aiming with the thumb requires great practice. During the preparatory exercises the instructors must impress upon the men the absolute necessity of bringing the point of the thumb, substituted for the notch of the back-sight, into the plane of fire, that is to say, it must coincide with the axis of the barrel.

The verification of the line of sight must be made before aiming. To do this, the soldier takes a sight of the vertical plane passing from the tip of the foresight along the line of the barrel; the thumb must be in that line.

When the position of the thumb is well fixed, aiming is no longer difficult. The instructors must take into consideration that the preceding rules have been calculated for a thumb of the average size, and they must be modified for soldiers whose fingers materially exceed the ordinary dimensions.†

All the men must learn the rules of firing with the carbine. The officers and non-commissioned officers must know them thoroughly, in order to be able to suggest them to the men when necessary. Frequent lectures must be given to the men on the subject, and the lieutenant-colonel is specially charged with the superintendence of this part of the instruction.

II. Judging Distance.—In addition to the usual mode of measuring

* In French the *capucine*. Of course the positions of our bands do not correspond exactly to those of the French.

† If this substitute for the back-sight has been found almost nugatory when firing from the ground, it must be absurd to attempt it on horseback. The hits were so few when I saw it used, that they may be considered accidental. However, the elevation might have been sufficiently accurate to be effective enough on extended lines. This is worth testing. Back-sight adjustment must be difficult and uncertain on horseback.

and judging distance, I find the following:—the instructor orders the men to walk their horses over the distance of 108 yards—100 metres, enjoining them to allow the horses to take their usual step without endeavouring to increase or diminish its length. A horse makes 120 steps to get over 108 yards, and therefore makes 60 steps for 54 yards, and so on. We may thus ascertain the number of yards gone over by counting the steps of the horse.

The instructor forms his detachment in a single rank at one of the extremities of a marked distance of 200 metres (216 yards) of the side where the measurement commences, so that the straight line measured will be perpendicular to the front of the troop, and pass through the centre of that front. Everything then proceeds much after the mode adopted in our judging distance drill and practice. It may be useful, however, to quote the following

Aids to Judging Distance.

At 600 metres (about 650 yards) we distinguish in a troop of cavalry:—the rate of motion—walking, trotting, galloping; the direction of the movement—advancing or retiring; the brilliant parts of the accoutrement—helmet and cuirass; the colour of the uniform—red, white; the breastplate, plume, the blade of the lances.

At 430 yards, we distinguish the saddle-cloth; the rates of motion and its direction; the helmet and cuirass; the bright colours of the uniform; the shoulder belt of the horsemen seen in front.

At 324 yards, we distinguish—the colour of the saddle cloth; the reins of the bridle on horses with light saddle cloths, seen sideways; the scabbard of the horseman's sword, seen on his left; the shaft of the lances; the epaulettes; the hair of the head.

At 216 yards, we distinguish—the colours of the saddle cloth; the reins of the bridle on horses with dark saddle cloths; the blade and scabbard of the sword; the shaft of the lance; the carbine slung; the principal parts of the uniform and equipment.

At 108 yards, we distinguish—the different parts of the soldier's body; his shape and arms; his weapons and equipment; the details of his uniform; harness; the line of buttons on his jacket, his holster, and cloak.

In a body of Infantry:—

At 650 yards, we distinguish—the movement of companies marching, advancing or retiring; the red colour of the trousers.

At 432 yards, the direction of their march; the movement of their muskets.

At 324 yards, the barrels of the rifles or carbines; the rifle at the shoulder; the different parts of the uniform.

At 216 yards, the colour of the uniform; the badges of the belts or shakos; the hilts of the swords; the cartouch box.

At 108 yards, the different parts of the body; the movements of the men individually; the form and colour of the uniform.

Objects in *motion*—at a horse *walking:*—

At 108 yards aim at the horse's shoulder; at 216 yards, aim at his nose.

At 324 yards, aim about ⅔ths of a yard before his head (half the length of the horse).
At 432 yards, aim in advance of his head one whole length of the horse.
At 540 yards, aim 9 feet 6 inches before his head (a length and a half of the horse).
At 650 yards, aim two lengths or rather more before his head.

At a horse *trotting*:
At 108 yards, aim at the horse's head.
At 216, aim rather less than his length beyond his head.
At 324, a length and a half beyond.
At 432, three lengths beyond.
At 540, four lengths beyond.
At 650, six lengths beyond.

At a horse *galloping*:
At 108 yards, half the length of the horse beyond.
At 216, two lengths.
At 324, four lengths.
At 432, six lengths.
At 540, eight lengths.
At 650, twelve lengths and a half.

These indications must not be considered absolutely correct. They must be taken as general approximations or averages, susceptible of modification according to the eyesight of each, atmospherical circumstances, and configuration of the landscape.

The lengths of the horse are approximately calculated in the proportion of two metres (6 feet 6 inches) as the unit at the walk, the trot, and gallop.

The soldier having been instructed in the proper method of loading, aiming, snapping caps, blank-firing, &c., precisely according to the method we enforce with the foot soldier—differing in a few particulars, perhaps unimportant, and having fired with ball cartridge at all the distances from 100 to 600 metres, he then commences his practice on horseback.

III. Practice on Horseback. *Preparatory Exercises.—Training of the Horse.*—This part of the instruction cannot be too carefully conducted. It is, in fact, the basis of the whole system. If the horse is not habituated to the report of the rifle or pistol, if he is not obedient to the hand and legs of the rider, it is vain to expect any useful results from the weapon. It is absolutely necessary that the rider should not be occupied with his horse when he has to use his rifle. The most essential point, then, is to habituate the horse to the report of the weapon. The prescribed means must be employed with the greatest perseverance if we would secure good results. When the troop is in line on the practising ground a single restive horse will interrupt the practice completely—his bad example infecting the whole troop.

Tact and patience on the part of the instructor can alone succeed in quieting the animals, and one of the most efficacious means is to isolate them—either placing them singly in column with intervals, or separating them one from the other, so as to give them the benefit of good example.

There must be no firing until the rider is perfectly master of his horse, and ball-practice must be out of the question until the preceding instruction

shall have been well understood and well executed. During the musketry instruction, the soldier should always ride his own horse, if possible.

1. *Position of the Soldier firing on horseback—at the Halt.*—The troop being formed in a single rank, three yards interval between each, and at the position of "Shoulder Arms," the instructor gives the following caution, and has it performed, substituting simple *indications for the words of command.* This is worthy of especial notice; it is impossible to teach shooting by word of command; this is a point in which the French system generally surpasses our own as now carried out.

Position on Horseback.—Lower the carbine to the left hand—partly open the left hand—seize with the right hand the part of the reins held by the left above the runner, the little finger between the two reins, the fingers fronting the body; raise the carbine with the left hand, bending the arm, the nails uppermost, and hold the carbine horizontally, the butt to the right, and at the height of the shoulder.

Aim and Fire.—Come to the "Present," slipping the little finger of the right hand to the end of the reins, the muzzle of the carbine pointed between the shoulder and left ear of the horse; cock the piece by seizing the comb between the thumb and the first finger of the right hand without quitting the reins, the butt at the shoulder; place the first finger on the trigger, fire without moving the carbine, seize the reins with the left hand, and come to the loading position, letting go the reins with the right hand.

This motion being performed, the soldier is practised in loading to fire again, or to sling his carbine in order to seize his sword.

At the "Present," the reins are let loose, in order that the carbine should not feel the heaving of the breast, and that the movements of the hand, connected with those of the barrel, should not be transmitted to the horse; but this position must interrupt the use of the reins only for a very short time, and the instructor should strive to curtail it by habituating the horseman to adjust very rapidly.

2. *Firing at the Halt.*—The troop is formed in a single rank opposite the target. A pole is planted in the direction of the company and the target, indicating the distance whence they will fire. In order to habituate horsemen to get themselves in position promptly, so as to fire on objects before them, on their left, on the right, or in the rear, the instructor makes them execute the following movements:—

Firing to the Front.—The named horseman advances from the rank, shoulders the carbine, takes the position of firing on horseback, and marches straight to the pole: here he halts, makes a right quarter face, makes ready, presents, and fires. He then resumes the advance, and after a few paces comes to the right about, and retires, loading his carbine, and forms ten paces in rear of the rank opposite the spot he occupied.

Firing to the Left.—The named horseman quits the rank, shoulders the carbine, takes the position of firing on horseback, turns to the left, then to the right, and advances straight to the front, towards the pole. There he turns to the right, and, when near, he halts, presents, and fires to the left. He then advances, returns, loading his carbine, and forms ten paces in rear of the rank opposite the spot he occupied.

Firing to the Right.—The named horseman quits the rank, shoulders the carbine, takes the position of firing on horseback, turns to the right, then to the left, and marches straight to the front towards the pole. There,

he turns to the left, and advances to the pole; when near, he comes to the right about five quarters, halts, presents, and fires. Then he comes to the left about five quarters, resumes the march, and returns, loading the carbine, and forms ten paces in rear of the rank opposite the spot he occupied.

Firing to the Rear.—The named horseman quits the rank, takes the position of firing on horseback, and marches towards the target in such a way as to leave it a little on the left. Having got up with it, he turns, and when he is between the target and the rank, on a line with the pole, he halts, rises lightly in his stirrups, turns, pressing the right stirrup, presents, and fires to the rear. He then resumes his seat, advances straight to his front, and returns, loading his carbine, and forms ten paces in rear of the rank opposite the spot he occupied.

When the troop can perform these movements correctly at the walking pace, they practise them at the trot and the gallop.

3. *Position when firing on the March* (the same preliminary movements as at the halt).

Present—Fire.—These movements are the same as at the halt, with this difference, that firing on the march the horseman must disengage his seat from the reactions of the horse during the time necessary to adjust and secure the immobility of the carbine: he rises lightly in his stirrups, presses the horse solidly with his knees, and leans forward, to aid in keeping his equilibrium, and favour the motion of the horse.

Firing on the march is directed to the front, to the left, and to the rear, as from the halt; at first at the walking pace, and then at the gallop. When they fire at the gallop the horsemen must give rather more rein to the horses at the moment when they come to the Present, in order to diminish the reactions of the horse, gently resuming the reins after firing, and falling lightly into seat.

The horseman must be practised at loading his carbine after having fired, or at slinging it in order to seize his sword.

These movements must be performed with celerity, in order to make good use of them in war. This instruction might be advantageously completed by placing beyond the target a head for the horseman to fire at or sabre.

4. *Snapping caps.*—When the troop has been sufficiently practised with the preceding "dummy" firing, they will go through all the movements, snapping caps, to be followed in like manner by blank cartridge, at the halt, at the walking pace, trot, and gallop.

At the halt it is difficult to ensure the perfect immobility of the horse, but tact and address will supply the deficiency, and the horseman should fire at the instant when the habitual stamping of the horse has just ceased, which he will feel by his *seat.*

The horseman must also be most careful so to direct the muzzle of his carbine that the stray grains of powder and the gas may never reach the ears of his horse.

5. *Individual firing at various distances.*—Ball-practice takes place when the men and horses have become sufficiently used to powder to permit the exercise to take place without danger. They fire at the halt, to the front, to the right, to the left, and to the rear—in marching at the walking pace and at the gallop, forward, and to the left. The regulation-distances for firing on horseback are 100, 200, and 400 metres—108, 216,

432 yards, nearly. Each distance-practice consists of four rounds to each man, fired on each occasion.

If any of the men are awkward at the practice, or any of the horses restive or not sufficiently steady, they are excluded from ball-practice.

RECAPITULATION.

Practice on Foot.	Officers, Corporals, Old Soldiers.				Young Soldiers.			
	Lessons.	Caps.	Blank Cartridge.	Ball Cartridge.	Lessons.	Caps.	Blank Cartridge.	Ball Cartridge.
PREPARATORY EXERCISES.								
1. Aiming	1	—	—	—	2	—	—	—
2. Position of firing on foot	1	—	—	—	2	—	—	—
3. Aiming and position on foot	2	—	—	—	3	—	—	—
4. Keeping the arm steady in the hands of the soldier	1	—	—	—	1	—	—	—
5. Snapping caps	2	20	—	—	2	20	—	—
6. Blank cartridge	1	—	8	—	2	—	8	—
7. Ball-practice at various distances	4	—	—	16	4	—	—	16

Practice on Horseback.	Officers, Corporals, Old Soldiers.				Young Soldiers.			
	Lessons.	Caps.	Blank Cartridge.	Ball Cartridge.	Lessons.	Caps.	Blank Cartridge.	Ball Cartridge.
PREPARATORY EXERCISES.								
1. Training of the horse	—	20	8	—	—	—	—	—
2. Position of the soldier firing on horseback at the halt	1	—	—	—	2	—	—	—
3. Imitation of firing on foot	1	—	—	—	2	—	—	—
4. Position of firing on the march	1	—	—	—	2	—	—	—
5. Firing on the march	1	—	—	—	2	—	—	—
6. Snapping caps	2	20	—	—	2	20	—	—
7. Blank cartridge	2	—	8	—	2	—	—	—
8. Individual firing at the various distances	3	—	—	—	3	—	—	12
School of Skirmishers	—	—	20	20	—	—	20	—

Pistol Firing.

1. *Rules of firing.*—The theoretical principles of the carbine are applicable to the pistol.

The rules of firing are confined to aiming at its point-blank range, and may be applied with sufficient accuracy up to 50 metres—about 54 yards, but practice reduces this distance to 25 metres.

As the cartridge is that of the carbine, it must be "bled" before loading, by throwing away a part of the powder, about one-half of it.* The exact measure of this powder to be thrown away is given by the capacity of the hollow at the head of the ramrod. Blank-cartridge has the regulation charge.

Firing with the Pistol.—The horseman is not to use the pistol excepting on horseback and when alone; but it is necessary to initiate him in the principles of firing with that arm, and teach him the details of position to facilitate their application.

For this purpose the men are placed as prescribed for aiming with the rifle, and the instructor gives the following explanation:

1. *Position of firing on Foot.*—Carry the right foot about 26 inches from the left; cock the pistol; raise it with the right hand vertically; the trigger-guard to the front; the wrist to the front and about 6 inches from the shoulder; the first finger extended along the trigger-guard.

2. *Present.*—Lower the pistol, the arm being half extended; place the first finger on the trigger, the muzzle pointing to the centre of the target. In this position the horseman must avoid squeezing his fingers, to diminish the trembling of the hand.

1. *Firing on Foot.*—The horseman is practised in firing to the front, to the left, to the right, and to the rear, following exactly the progression and series of the preparatory movements indicated for the carbine.

2. *Firing on Horseback.*—The horseman is placed and practised as prescribed in the firing on horseback with the carbine, taking, however, the position indicated for firing on foot with the pistol. He fires to the front, to the left, to the right, and to the rear; from the halt, at the walking-pace, and at the gallop.

I omit the "Theoretical Instruction" † of the French Manual, as being sufficiently understood by all, and substitute instead the following remarks by General Bonneau du Martray; they are at least curious:—"As no one doubts that the rifle will play a much more important part in the success of future battles than hitherto, it is of the utmost importance to train good shots. We say, in the first place, that the use of the elevating sight is too slow and too difficult in battle; it will even cause the loss of some of the advantages of breech-loading. The determination of the distance, and, consequently, the adjustment of the sight, are liable to error, and the time required endangers the loss of the favourable moment for firing. On the other hand, supposing the line of sight exactly found, we must next make it coincide with another right line—that which extends from the eye to the target or object; in other words, we must place in one line four different points, the eye, the notch of the backsight, the tip of the foresight, and the target, an achievement by no means easy, especially if, in addition to it,

* This seems a strange waste of ammunition, if not absolutely necessary "by the exigencies of the service." I find that there is a special cartridge for our carbine and pistol.

† I had translated and adapted the whole of this little manual, thinking it might be adopted by our authorities for the cavalry.

the rifle must be held at the shoulder. With certain physical conformations—too long or too short a neck—firing from the shoulder renders the desired coincidence utterly impossible. We think, therefore, that in the field we should abolish the use of the backsight.

"It is not absolutely necessary to hold the rifle at the shoulder to make good practice in firing. In support of this averment we will draw attention to the fact, that it is nearly certain that the resistance given to the recoil of the rifle augments the deviations of the bullet, and we will quote an historical account, which we are not bound to believe, but which suggests incontestable proofs in confirmation. The account occurs in the book of Father Huc, apostolical missionary, on China, vol. i. ch. 10. It is as follows: 'The Fusiliers and Archers then practised at the target; their skill was remarkable. The Chinese matchlocks have no butts, but terminate like a pistol. When they fire they do not hold the matchlock at the shoulder; they hold it at the right side, at the height of the haunches, and, before letting down upon the priming the hook that holds a lighted match, they fix their eyes upon the target. We remarked that this mode of procedure was eminently successful, which seems to prove perhaps that to fire accurately with the rifle it is less necessary to sight with the top of the barrel than to look steadfastly on the object.'

"These last words are completely in accordance with facts perfectly admitted, and prove our proposition, namely, that it is not necessary to take a line of sight to hit an object, and that it suffices to look at it steadfastly, with a strong will to hit it with the bullet. Thus the stone that whirls in a sling, describing a circle and escaping at an instant which indicates only an internal instinct, the quoit thrown by one hand which retires and then advances, the end of a stick which describes a circle round the shoulder to strike accurately a point suspended in space, are all instances in point [to which we must add that of the Australian boomerang in its otherwise incomprehensible gyration].

"In these different examples the chief point is the attention and intention of the operator powerfully concentrated on the object; and we are led to suppose that by a physiological cause, analogous to that which forces a muscle to bend or extend, the stone, the quoit, the stick-end, through the apparatus of nerves forming the medium of communication with the mind, becomes as it were endowed with the magnetic will of the operator, and obeys him as long as the impulse is not victoriously counteracted by gravitation, the resistance of the air, the insufficient initial velocity, &c.

"This theory—a direction impressed to a projectile as it were by a sort of magnetic power—seems confirmed both by the example of savages skilful in the use of the bow, and by the practice of certain hunters (the most skilful) who content themselves with steadfastly looking at the game, following its movements with their eyes, then bringing the rifle to the shoulder, and instantly touching the trigger without taking time to aim. Some years ago, at Paris, there was an exhibition of South American savages and their war exercise. All drew the bow with rare precision, holding it vertically, the right-hand at the haunch, the head elevated, and the eye looking steadfastly at the target. And, as another example, we will quote the description of an English sportsman given by M. Mangeot, a renowned gunmaker of Brussels:—

"'The son of proud Albion never lowers his head, even before his game

fleeing in a straight line. At its departure he full-cocks, his head elevated so as to follow all its movements with his eye. When he thinks it sufficiently far to allow him to fire at a fair sportsman's distance, he brings the butt of the gun smartly to the hollow of his shoulder, at the same time directing the muzzle to the object, the elbow slightly raised to preserve the equilibrium of the piece, and without an instant's delay he touches the trigger, so that these two movements are simultaneous.'

"From the above facts we conclude that it is not absolutely necessary to place the butt to the shoulder, nor to take a line of sight; that it is important to fix the eye on the object at the moment of firing; and that consequently, if we wish to hit an enemy situated sufficiently far to require us to aim above his head, if we discard the backsight (whose use is impracticable in battle), we must then, instead of sighting, place the butt at the hip, and endeavour empirically at each distance to incline the arm to the proper elevation before firing." *

No doubt this suggestion of the gallant French general will be laughed at by many. Nevertheless the facts of his logic are worth consideration, if only to modify certain imperious inculcations with which not one man out of a hundred can perfectly conform in order to be a good shot with the rifle. Cultivate the strong will to hit,—that is the secret. If all cannot succeed in doing so, it proves that we have something else to do besides inventing a perfect rifle, of which fact the French are perfectly convinced. In the event of invasion our sportsmen and their gamekeepers will prove the truth of this remark, although it is notorious at Hythe that they fail to hit the target with an Enfield when firing according to the regulation method. The conclusion drawn from this last fact has been just the reverse of what it ought to be, and therefore the French general's observations may not be useless in our present meditations, which should be very serious.

Having, in the rifle, lost the flat trajectory and great initial velocity of Brown Bess, and its certain efficacy at the shortest distances, we must train the soldier so to use his Enfield that it may not fail him at a most critical moment, when Brown Bess would save him. The soldier must be "habituated" to hit at the shortest distances, instead of stimulating his ambition to excel at "long range" on the target-ground. Let him have practice within the 100 yards, and train him, moreover, to "judge" the distances beyond up to 300 yards with certainty, or at all events with sufficient accuracy to hit a man or a horse somewhere, if not in the centre, "without the use of the back-sight"; or, rather, by merely using the notch with the flap in its bed. Unless this is done our soldiers will have to regret the loss of Brown Bess on many a fatal occasion. It has been said, that our gallant soldiers of old "won their victories in spite of Brown Bess." Experienced military men, who have seen service, are not of this opinion. They owed their victories to their valour and Brown Bess united, and the rifle will never do what she did unless we take counsel beforehand to obviate its difficulties, and make up for its disadvantages.

IV. To stimulate the exertions of the cavalry prizes will be given.

These are, one to the non-commissioned officers of the regiment, four to the corporals and privates, consisting of 15 francs for the latter and 30 francs for the former.

They fire on foot and on horseback, but the competition on horseback is

* Nouvelle Methode de Guerre, &c.

confined to the best shots. The competitors must fire in complete equipment and marching order.

The prizes must be distributed, if possible, in the presence of the Inspector-general, and must be recorded in the instruction returns of the regiment.

The target is placed at 200 metres for firing on foot, and at 100 metres for firing on horseback. Only four rounds are allowed, and the prizes are awarded according to the smallness of the deviations from the centre in the total of the four shots.

All the French cavalry are provided with pistols. Field-Marshal Radetzky said, "All cavalry should be provided with pistols, for a fire-arm is often of great service to a horseman for personal defence, and quite indispensable to give an alarm or signal." Yet our dragoon-guards, heavy and light dragoons, and hussars, are not now, as formerly, so armed. But these weapons form part of the equipment of the household brigade, general, field, and mounted officers of every branch of the army, except of brigades and regiments of artillery, and those with repeating breeches are universally used.

"A mounted man," says Mr. Russell, "if he has only one revolver, should always carry it in his waist-belt, and in the case, so that, should he fall, he may avoid the injury to which he is otherwise liable from falling on the pistol. He ought not to place it in the holster, because if he is separated from the horse he loses the weapon. If he has two revolvers he can put one in his holster and the other round his waist."

PART II. THE IMPORTANCE OF CAVALRY DEMONSTRATED, AND THE RECENTLY ADOPTED FRENCH MODE OF TRAINING AND PROPOSED CAVALRY TACTICS EXPLAINED.

1. It is most important to bear in mind that the first military nation of the world not only retains, but actually expands, and trains to the utmost extent, that section of her splendid army, which recently some of us thought of converting into general carriers of baggage—supposed to be rendered otherwise utterly useless by the all-devouring rifle. Cavalry, in fact, would never dare to stir on a field of battle! If the light cavalry might be permitted to exist, to be made otherwise "generally useful," the heavy cavalry, at all events, should be utterly abolished, just as if the two things were not perfectly distinct in their use and application—each having its special function in the field of battle.

In the last century, when fire-arms were improved, the same notion prevailed, and it was thought proper to keep cavalry carefully at a distance, out of the reach of fire. It became inactive, and was nearly considered only secondary in the tactics of battle, when a man appeared, who set it free, and gave it wings, and won with it victories that seemed to belong to heroic poetry, not the annals of facts and history—the renowned SEYDLITZ.

Happily, no nation thinks of abolishing, or even diminishing its expectations from, that arm in future warfare—least of all the French, whose cavalry at the present moment is in a perfect state of training, not only as to the vigorous gymnastics of the martial circus in splendid and astonishing variety, but also as to the efficient use of the rifled carbine with which it is furnished.

If the intrinsic value of cavalry seems to have been lessened in many respects, if this arm no longer dazzles with its ancient splendour, the cause is not in the arm itself, it must be sought elsewhere; and our cavalry may sink into utter decadence if we do not advance it to the level of the other arms of the service—in its organization and employment—in its training and requirements.

To dare everything—to risk everything—even the impossible—was the characteristic of cavalry two hundred years ago. On the 1st of January, 1658, the great Polish hetman Czarnecki actually swam his cavalry across the Little Belt! Several times the Poles and the Swedes crossed the Dnieper and the Elbe with entire corps of cavalry. Will the cavalry of the present day march fifteen miles and fight a battle, as did the cavalry of Torstenson in 1645 at Juterbok? Can we expect the cavalry of the present day to take a part in the attack and defence of cities, as it did constantly during the Thirty Years' War?

Unquestionably the most difficult military problem is to bring our cavalry to the field of battle in a fit condition for fighting; that is to say, starting from a given point, how to reach our destination with the smallest loss of men and horses. For the experience of ancient wars demonstrates that, on an average, regiments crossing the frontiers lose one-fourth before they reach the field of battle, by sheer exhaustion, or its concomitants.

Hence the absolute necessity for training—systematic training—for all soldiers, and especially the cavalry-compound, man and horse. Mere field-day parade and drill are not the training for such cavalry as the Great Napoleon wanted, when he exclaimed, "If I had had sufficient cavalry at the battles of Lutzen and Bautzen, I would have re-conquered Europe."

2. As there may still be lingering doubts respecting the function of cavalry in future battles, a few of the hasty surmises against it must be discussed and refuted. The principal objection recently advanced against the utility of cavalry is the introduction of the rifle and rifled cannon. A letter written by one of the French campaigners in the late Italian war seemed to prove the utter inutility of cavalry, by announcing that, at 2,500 yards, the eighth battery of the 16th regiment threw into disorder a squadron of Uhlans (light cavalry) at the battle of Solferino, and that, following up this favourable result, several batteries opened fire from the same distance upon twenty-five squadrons ready to charge, and forced them to the rightabout. This precious achievement of the Emperor's truly beautiful howitzers has been upheld as a proof that cavalry should be abolished. Now, what were the facts respecting these Uhlans? They belonged to Mensdorff's division, which, to the very end of the battle, never ceased to front the fire of its enemy—not at the distance of two miles, but at close quarters. Several times they charged MacMahon's right, and penetrated almost to the very muzzles of the 72nd and 11th Chasseurs à Pied—the hand-artillery of the French army. They got within 200 yards of Vinoy's division in Neil's corps, and they only retired before the grape-shot and balls of 42 pieces of artillery of the divisions and reserves of that corps; and during the night following the battle these Uhlans aided in covering the retreat towards the Mincio.

Besides, at 2,500 yards, how is it possible to distinguish between a change of position having no reference whatever to the firing in question, and a rout caused by it, as alleged by the letter in question? Is it at all

likely that cavalry would make ready to charge at 2,500 yards? Why, the horses would come in utterly blown and incapable of any serious effort. The battle of Solferino was a fortuitous affair, a series of fights spread over a front of nearly twelve miles, on ground utterly unfit for the movement of cavalry. Besides, it is a fact, that the Austrian cavalry was most improperly handled on that occasion. *

Most assuredly we have as yet no proof that the rifle will be the annihilator of cavalry in the field of battle, but perhaps just the reverse. The introduction of the rifle urges the cavalry into new life, and enlarges its field of operations.

3. The comparative immunity to be expected by cavalry from the modern rifle, has been amply discussed in a previous paper.† In theory the rifle is a dead shot; in practice, however, by not complying with its requirements, we make it worse than "Brown Bess." An advancing troop is at every instant safer and safer from the rifle-bullet, owing to the great curvature of its trajectory; whereas, with "Brown Bess," the soldier, aiming right upon the galloping line, the barrel parallel with the ground, saw his chance of emptying a saddle or upsetting a horse increase at every second of the charge. Of course, the rifleman can alter his elevating sight, but, alas! under what circumstances? At an object constantly altering the distance, in the midst of smoke and dust, the advancing squadrons making the earth quake under their resounding hoofs, and in momentary expectation of the formidable shock when the cavalry will be upon him!

4. We must not, therefore, exaggerate the effect of the rifle in future warfare. Its influence will be greater on the tactics of the battle-field than in the destruction of armies. In future, the lines and the reserves will be posted at greater distances. Column movements will be interdicted where they might formerly be safely ventured. We shall have to deploy much quicker than formerly. We must advance in line or in columns of companies at wheeling distance, in echelon oblique or direct. All diversions on the field of battle, all movements to turn the enemy, will require a greater radius.

Hitherto armies have encamped or bivouacked at from 2 to 3,000 paces from the enemy's outposts. This will no longer be safe, because the position can be accurately shelled by rifled cannon. Hence, on the other hand, the necessity for having at the outposts a greater number of squadrons with light batteries, in order to ensure the safety of the army.

The least change of position, up to 5,000 paces from the enemy's lines, will be of serious importance. And the movements and bearing of our skirmishers will require the utmost development, and become of serious consequence on the event of the battle.

Now, it is evident that these urgent modifications of our tactics positively enhance the value of cavalry, and render its employment more necessary and efficacious. For, the more we develop the movements and action of the skirmishers, the more we extend our lines and augment their distance, the more we need divisional cavalry. The more we increase the space separating the contending armies, and the greater the distance of the infantry reserves from the main body in action, the greater the

* General Renard, "De la Cavalerie," p. 129, *et seq.*

† "Military Gymnastics of the French," Part II. published in Vol. V. of the Journal of the Royal United Service Institution, and as a pamphlet by Mitchell, 39, Charing Cross.

necessity for cavalry reserves and light artillery, in order to reinforce promptly those points which may be compromised, and to check for a time the efforts of the enemy. Thus, cavalry and light artillery, well trained and capable of rapid movement under any circumstances and on any ground whatever, are more necessary now than heretofore; the function of cavalry, in our modern tactics, will be enhanced in importance and admit of greater development.*

4. Infantry is decidedly the mainstay of battle. It is the army's centre of gravity. It is adapted to all sorts of ground,—plains, mountains, and broken country. It is endowed with the two essential qualities of action, the bayonet and the bullet; but these faculties are limited by the inherent weakness of man, and by the range of his weapon. The deficiency in the strength and resistance of the infantry is supplied by the cavalry and the artillery, which, although they have but one of these faculties—strength, still this faculty in the cavalry and the artillery exists to an extent which the infantry can never attain. Defeat to the infantry in an open country, unsupported by sufficient and good cavalry, is fatal; and every victory, in the same deficiency, must be always undecisive.

With equal *morale*† an army, consisting only of infantry, will be beaten by an army much weaker, but consisting of infantry and artillery; and with still greater certainty by an army combining the three elements together, infantry, artillery, and cavalry. Moreover, in an open country,

* General Raynard, *ubi suprà*, p. 154.

† The following quotation gives some idea of the French estimate of *morale* in an army:—"As it is a favourite saying among French soldiers, *C'est le cœur qui fait le grenadier*—'tis the heart that makes the grenadier,' so, on a larger scale, it was invariably a maxim with Napoleon that the value of the *morale* to the *physique* of an army was in the proportion of two to one; and, as a striking illustration of the prevalence of this sentiment, we may state that, during the Peninsular war, in several instances there fell into the hands of our Engineer officers the governor's daily report, during the different sieges, of the strength of his garrison, in which the hourly fluctuations of "la morale des troupes" were as carefully recorded as the motions of the weathercock at our Observatory at Greenwich."—Sir Francis B. Head, Bart. "The Defenceless State of Great Britain," p. 241, a new edition of which work should be published in a cheap form at the present time, since its patriotic and terrible warnings are even better grounded now than they were in 1850. Something has certainly been done by way of national defence, but what is it relatively? If you content yourself with one or two indecisive moves whilst your antagonist makes as many as he likes, is there no danger of being checkmated? In his remarkable letter to Sir J. Burgoyne, the Duke of Wellington said: "I know of no mode of resistance, much less of protection, from this danger, excepting by an army in the field capable of meeting and contending with so formidable an enemy, aided by all the means of fortification which experience and science can suggest."

"The Duke, however," adds Sir Francis Head, "assuming, as a national axiom, that the British House of Commons would constitutionally shrink from the expenses of enabling Her Majesty's army and navy to defend the nation from invasion in the proper manner, suggested the formation of a militia force of 150,000 men. This, he adds, with an augmentation of the force of the regular army which would not cost £400,000, would put the country on its legs in respect to personal force, 'and I would engage for its defence, old as I am:' But the ink with which these chivalrous words were written was scarcely dry before reflection materially modified the enthusiastic declaration: 'I shall be deemed foolhardy,' he adds, 'in engaging for the defence of the empire with an army composed of such a force of militia! I may be so; I confess it. I should infinitely prefer, and should feel more confidence in, an army of regular troops; but I know that I shall not have these; I may have the others. This is my view of our danger and our resource.'"—"The Defenceless State of Great Britain," p. 377.

A regular standing army in England of 100,000 infantry, with proportionate cavalry,

and unsupported, infantry will be demolished by cavalry with sufficient artillery at its disposal. Its destruction would only be a question of time, even if it has the heroism of Napoleon's Guard at Waterloo.

Every movement within range of the enemy's fire, or on the field of battle, constitutes a weakness—a state of weakness in the infantry; the movement may be compromised if it be not supported and protected by cavalry. At the moment when he was hurling his division against Zach's column at Marengo, Dessaix exclaimed, "Go, tell the First Consul that I am about to charge, and must be supported by cavalry." In the same battle the divisions of Victor and Lannes would have been crushed, had they not been aided by Kellerman and Champeaux's cavalry. Without Murat's cavalry at Eylau, Augereau's corps, and perhaps the whole French army, would have been defeated. But why need we seek under foreign standards the proofs of the fact that the cavalry is the tutelary god of battles? At Waterloo, Ponsonby's Dragoons hurled D'Erlon's infantry into frightful disorder, whilst advancing without the support of cavalry. They sabred the men and the horses of the artlilery in its rear. The rout was complete, and retreat was only made possible by the late arrival of Travers's Cuirassiers and Bro's Lancers. On the other hand, on the left, a single brigade, Guyot's, posted against La Haie Sainte, kept its position for a long time against the centre of the entire English army, thanks to the efficient aid of Dubois' Cuirassiers. These undaunted soldiers, isolated in the front of the army, not only drove back the enemy,—they mounted the plateau alone, and crushed Lünebourg's battalion, captured his standard, charged Allen's division, and only gave way to Uxbridge's squadrons, who were subsequently checked by Guyot's battalions.

5. Infantry and cavalry are indispensable to each other, and this fact has never been more strikingly revealed than in small armies, fighting on the defensive, and on their natal soil. A large army, taking the offensive, does what it likes, acts according to a plan of its own choosing, and seeks the enemy to give him a decisive battle. The possession of the initiative permits it to employ a comparatively weaker cavalry. Nevertheless the services it receives from this cavalry are not less considerable. Thus, in the splendid march of the French on Marck's line of operations in 1805, Murat's squadrons were in the van. They seized the bridges and defiles, and by their rapidity they co-operated more than any other arm in isolating the Austrians in their position at Ulm; and they won the first laurels of the campaign at Wertingen.

6. An army on the defensive, however, is subject to the enemy's combinations. It remains as it were in a state of enchantment as long as the enemy's intentions are unknown. It needs scouts in every direction, and at a distance, and must have sufficient reserve of cavalry to oppose the first efforts of the enemy, in order to give time to the other troops either to accept battle on a chosen position, or to decline it by retreating. A small army, declining a general engagement, and yet anxious to check the ad-

and a better organised militia—these are our wants; and, until we are so protected, the "idea" of invasion will always hang over us until it is realized, and then, God help us! In the face of such defence the "idea" would never be entertained. An efficient fleet is indispensable; our Volunteers should be fostered; but a *competent army and militia are vital to the empire.*

vance of the enemy, can obtain this result only by manœuvring, and by endeavouring to deal the enemy decisive blows as often as it can without a general engagement, and without compromising the fate of the whole army. The blows must be quick—dealt as it were by surprise; and it is on such occasions that a general contemplates with pride and satisfaction in the ranks of his troops a numerous and staunch cavalry, and an artillery equally staunch and numerous. These are the guarantees of success in the rapid marches and surprises which he designs, or in the defensive battles which he may be forced to accept.

We have a celebrated example to uphold these tactics—the French campaign of 1814. In that campaign the effective of cavalry always exceeded the fourth of that of the infantry, and in some battles it reached the half.* The last days of the imperial cavalry shone with incomparable splendour. Its triumphant success is indissolubly connected with the immortal battles of the 10th, 11th, 12th, and 14th of February. At Champaubert the dauntless cavalry of Girardin and Doumerc charged and pursued Olsouvieff, the Russian infantry was sabred and hacked to pieces by the cuirassiers, 1,500 killed and wounded, 3,000 prisoners, 20 guns captured, Olsouvieff and his staff being amongst the trophies of the victory. At Montmirail, Nansouty's cavalry killed 3,000 of the enemy, made 4 to 5,000 prisoners, and captured 30 guns. At Château-Thierry, the same warrior with his cavalry cut off the retreat of the enemy, sabred its cavalry, and captured its light artillery,—whilst Letort flung his heroic dragoons upon three Prussian and Russian battalions, pierced through them, and brought back 3,000 prisoners and a numerous park of artillery. At Vauchamps, Ziethen was charged by Grouchy's heavy cavalry, and left in his hands 2,000 prisoners, 12 guns, and several standards; and, not content with this, those admirable squadrons of cuirassiers dashed off in pursuit of Blucher himself, and, from eleven o'clock of the morning to three of the afternoon, they harassed and hung upon him, picked up thousands of soldiers in the pursuit, and then they started at full trot across the woods, alone and without artillery, and attacked without hesitation the Prussian masses in full retreat, which Blucher had the greatest difficulty in leading back to Etoges.

On the 17th, at Mormant, the Russians suffered a similar defeat by the dragoons from Spain; at their head Milhaud and Valmy attacked the Russian squares of Pahlen, broke them, and made them prisoners *en masse*, together with their artillery, whilst they scattered and put to flight the cavalry which attempted to come to the rescue: 4,000 men—prisoners, killed, and wounded—rewarded the conquerors.†

No wonder that the Duke of Wellington declared to Jomini his unqualified approbation of the French cavalry. He said, "After having personally borne the brunt of their audacity and perseverance at Waterloo, I know of none capable of surpassing them." And it will be in the recollection of the readers of these pages that Napier, in his "History of the Peninsular War," felt compelled to declare his opinion respecting the

* The total strength of the French army on the 25th January, 1814, the day on which the Emperor Napoleon took the command, was 71,012 men, namely, 48,682 infantry, 15,478 cavalry, and 6,852 artillery.

† General Raynard, *ubi suprà*, p. 81, *et seq.*

French cavalry in terms by no means flattering to our national pride;* but, if he had reason then to think the French cavalry superior to ours, it is our duty now to ensure a contrary opinion in the pages of future historians.

8. In addition to the *physique* of man and horse, there must be the intelligent and rigorous training of both. The "sufficient cavalry" required by Napoleon at Lutzen and Bautzen was not merely numerical:—cavalry is only sufficient when it is up to its work, and then it is all-important for a "crowning victory." Saint-Arnaud, writing to the Emperor from the battle-field of Alma, said, "Sire, if I had had cavalry I would have obtained immense results, and Menschikoff would no longer have an army." At the recent battle of Montebello the want of cavalry gave General Forey a fruitless victory. Excellent infantry will not be pierced by indifferent cavalry: but excellent cavalry will always beat indifferent infantry; and the want of cavalry arrested even an Alexander and a Cæsar in the midst of their conquests.†

What are the requirements of this training to produce excellent cavalry? By constant practice both man and horse should be habituated with every kind of ground—should be led through narrow, winding, rugged pathways, uphill and through by-ways and valleys leading to a plain—where they may be suddenly halted, formed in line of battle, and advance at the trot and gallop.

They should be familiar with the difficulties of ploughed fields—be able to pick their way through woods and defiles—to cross a stream by boating, fording, and swimming.

Carrying his bread and forage for his horse, let every man be ready and start for a military march of a certain number of miles; then bivouac, as in real warfare; and, as in war-time, despatch a squadron from the garrison some 12 or 15 miles to reconnoitre, as in the vicinity of a supposed enemy.

Divide the troop into two bodies—throw them off in different directions—bring them into sight of each other suddenly—and form them in the best position that circumstances will allow for mutual attack.

It is obvious that all this requires a thorough love of duty, intelligence, and a strong heart, as well as nerve and sinew, on the part of men and officers; but then, are we to be left behind in the race after efficiency, not to say perfection? Is it a fiat of Providence that England must always be unready—must always suffer disaster before she can make good her claim to the place she holds amongst the nations?

9. It was the opinion of Napoleon I., and it is that of Napoleon III., that all the cavalry should be armed with carbines. Good cavalry officers have objected to this view; the subject is important, and deserves serious attention.

* Vol. v. p. 327 (French translation).

† It may appear pedantic to allude to martial antiquity in support of modern conclusions, yet Napoleon I. formed himself upon its models, and now Napoleon III. is at the present time engaged on a new translation of the great Conquestador's "Commentaries on the Gallic War." Nay, he has even had constructed a model *trireme*, such as used by Cæsar in his fillibustering expedition! The idea tickles the fancy of us who in our school-days sympathised with the Britons in their unequal contest with Cæsar's veterans. Is the idea ominous? What a plague is this our insular fancy, constantly tormented by realities which seem like dreams, and by dreams that may turn out realities!

Marshal De Servan was strongly of the Emperor's opinion; he maintained that the carbine and *bayonet* are indispensable to cavalry when fighting on foot; that they could not be inconvenient in any circumstances; and that these arms might be even necessary to cavalry when fighting in a body, when on detachment, and to single horsemen left to their unaided resources.

There are many occasions in war in which the cavalry cannot fight on horseback; there are others wherein it is not necessary that it should fight in that manner; and it may sometimes be utterly impossible so to fight. The cavalry cannot fight on horseback in hilly countries, in countries covered with woods or planted with trees and vineyards, or cut up by canals, streams, and ravines. What shall we do with it? It must either be sent to the rear, or be made to fight like the infantry. If we send it to the rear, we must leave unguarded some point of the front, some important pass, or weaken the positions of the infantry. Now, in all these cases we double the danger and fatigue of the foot-soldier; whilst the horseman, rendered useless, and worried by his idleness, waits impatiently for an opening to mingle in the fight.

"I say worried by his idleness," says the Marshal, "from my knowledge of the French cavalry. In every campaign the cavalry is disgusted with the obstacles which prevent it from exposing itself everywhere, like the infantry, for the defence of the State." Such was the situation of the cavalry in the Crimea, and such is at present that of the regiments which have not yet been led to battle.

In the attack of fortresses, towns, and lines, and whenever we must advance step by step, the cavalry is reserved for exterior service, which seldom gives it sufficient occupation; and when we come to the assault it can only look on tamely, waiting until the walls are destroyed, a gate opened, or a part of the line cleared out, to aid the infantry in demolishing the few soldiers that may remain to resist.

Had the cavalry been better armed and trained to use its weapon, it might have been actively employed and enabled to share the victory. The emulation of corps of a different nature would have produced the happiest results. It was thus at Novara, in 1522, when Montmorency, on the refusal of the Swiss, ordered his cavalry to dismount and advance to the assault.* The bold and chivalrous Charles XII. of Sweden modified his cavalry precisely in this manner. He gave it a great relative mobility, hurled it against troops of all arms, even against fortified positions, through all sorts of obstacles and over every kind of ground; and his horsemen, full of confidence, indefatigable in the attack and pursuit, knew no difficulty in their achievements. In the defence of lines, posts, villages, and even fortresses, the inconvenience of the cavalry's arms is equally felt; if they fight at all it must be at fearful odds.

Again, suppose a detachment of cavalry, a company for instance, is pursued by a detachment of the same arm, but consisting of a squadron. To fight, to run, or to surrender, are the alternatives at present. The first is of course the most glorious, but its glory is useless. To surrender without

* Under Francis I. the Swiss employed as auxiliaries often refused to march, under the pretext that they were not punctually paid; hence the proverb, "No money, no Swiss:" *point d'argent, point de Suisse.*

a blow is a painful extremity to brave men. To run for it is more simple; but the enemy is on your back, at your heels, and, whilst shame forces you to check your horse, glory gives the spur to his charger.

Now, if this company had been armed and trained so as to be able to fight on foot, what would its leader do? He would look about him. He would fix his eye on a house, a ravine, a hedge, a wood, and with the utmost speed make for it. There he would take post, under cover, and defend himself, like the infantry, and repulse the enemy, like the infantry.

Again, suppose one or several horsemen dismounted in a charge, they must retire behind the infantry. In this position, the luckiest of all, they have to regret their inability to mingle in the charge and win distinction. If they have and can handle their carbine, with the bayonet, they may still come in to share the honours of the brush.

Perhaps it will be said that a cavalry-soldier is a precious man and we must take care of him. Decidedly, good horsemen are not as plentiful as mushrooms; they are a work of time and long labour and must be treated with caution. An experienced general would not employ cavalry on foot excepting in cases of absolute necessity.* To be prepared for an emergency is at least half the difficulty got over; and, if all the occasions just alluded to are of constant occurrence in war, it is our duty to take them into account, and endeavour, by wise improvements and intelligent training, to be found equal to those occasions on their occurrence.

Armed with a carbine an isolated soldier might keep at a respectful distance several adversaries not so provided. In Egypt and Russia, the Mamelukes and Cossacks, having only pistols, were always in great dread of the fire of the French cavalry. In hilly countries, the cavalry would be often exposed to the danger of being cut off if unable to throw out skirmishers in the woods and on the rocks, to protect its line of march. In a reconnaissance near Ostalricho in Catalonia, General Gouvion Saint-Cyr was nearly killed or taken prisoner by the Miguelites: a part of his dragoons dismounted, climbed up the rocks in spite of their big boots, and delivered their general by routing the enemy with their carbines. In 1796, in the gorges of the Brenta, an Austrian corps of considerable strength was obliged to surrender, because, being attacked in front and on the flank, it could not retreat—a regiment of dragoons having dismounted and blocked up the passage. History is full of similar examples.†

10. After the Italian war the attention of military men of all nations was directed to France, to see what changes she would make in her army, especially as to the cavalry. For, certainly, the French cavalry did little or nothing on that occasion, the consequence being, that, although the Austrians were historically beaten off the field, there was never a rout, and, consequently, never a complete victory—such as were required in the old empire. High military judgments, however, have been advanced as to the impossibility of cavalry action in the Italian campaign, owing to the nature of the country; but it now turns out, beyond the possibility of doubt, that the French cavalry was positively wasted on the march, rendered unfit for action, and reduced to insignificant dimensions. They entered Italy with

* Système de Guerre Moderne, p. 83, *et seq.*
† Gen. Dufour, Cours de Tactique.

10,600 horses, and at Solferino they numbered only 3,000, more than two-thirds having been rendered useless on the march.*

France now possesses 61 regiments of cavalry,—36 of heavy, and 25 of light,—presenting a mass on war footing of 60,000 horses, at least; but, in the event of war, there can be no doubt that her cavalry will not be less than as 1 to 5 of her enormous infantry. The utmost endeavours are now being made to bring this numerous cavalry to perfection, by developing individual instruction, by a better class of horses, and by lessening and rendering more comfortable the weight of both the heavy and light cavalry.

A better carbine has also been given to the cavalry, which, however, will soon be displaced by a breech-loader devised by the Emperor. Its calibre is about nine-twentieths of an inch,—about that of the Whitworth rifle, its weight about 5 lbs.

The cavalry is trained to fight on foot—*en tirailleurs*—as skirmishers. Formerly three of four men would dismount, leaving their horses in the charge of the remaining horseman; but a shell bursting in the vicinity

* "Miscellanées Militaires," by General Grand, President of the Cavalry Committee at the French War Office, p. 20. There is ample instruction in this Blue Book, or Official Report, quite consolatory to us in England, so familiar with blunders and shortcomings. We are plainly told that the French cavalry in Italy, "instead of being united in the hand of an able leader, lacked proper and firm direction, which might have taken a vigorous initiative on every occasion, regulating the details of its marches and service, and, with adequate experience, looking to its wants and interests. Instead of keeping it in reserve to employ it according to circumstances, the ground and its own requirements, in directing the movements of the army, or in completing its victory, the cavalry was frittered into weak fractions; its marches, its hours of departure, were the same as those of the infantry, which, by reason of the excessive heat, was very slow, the columns being frequently retarded and halted, causing accidents and compelling the men to dismount.

"In conclusion, it results from all these observations that the causes of the numerous injuries of the horses in the Italian war may be attributed—

"First. To the weakness of the effective of the regiments of cavalry during the time of *peace*, and, consequently, to their want of *morale* and individual instruction.

"Secondly. To the sudden augmentation of this effective by means of men without experience, and young horses barely trained and hastily harnessed.

"Thirdly. To the introduction of men from other corps, unknown to their leaders, and not always having the requisite zeal and good-will.

"Fourthly. To the want of superintendence on the part of the officers during the march.

"Fifthly. To the fractional distribution of the cavalry in the various *corps d'armée*, and under the orders of officers of another arm, instead of its concentration in the hand of an able and experienced commander.

"Such seem to be the principal causes of the wounds of the horses of the Italian army, the bad quality of the harness being only secondary. Nevertheless, we must not dissimulate the fact that the saddle in use is not free from grave defects," &c. &c.

The whole report should be read by those whom this matter concerns here in England; it is full of useful suggestion. The following opinion is much to my purpose in the present article:—"It would be useful to complete the trial now being made of the regiments changing garrison, by requiring the divisions of cavalry at Châlons and Lunéville to carry constantly, in the manœuvres as on the march, the whole weight that the horses have to carry in a campaign. Up to the present time the camp at Châlons has only been an assemblage of troops whose special object has been merely tactical instruction; but, unfortunately, we have neglected an essential part of the business—campaign service. All the operations of these camps should be the image of what is done in war. Instead of contenting ourselves with manœuvres, we should habituate the officers and soldiers with the various turns and twists of warfare. At every turn-out the bivouac should be raised, just as if we had to decamp and take a position elsewhere. However fatiguing or harassing these obligations may appear, it is certain that they would give a better idea of those imposed upon us by actual warfare." Does this not apply to our Aldershott and the other miniature Châlons of England?

would throw the horses into confusion. Now they follow a different method. The men number off rapidly from 1 to 4. The even or odd numbers, according to the word of command, dismount and throw the reins to their comrades remaining on horseback and in the ranks. The officers following the skirmishers are immediately succeeded by others, and the squadron continues its movements just as if all were mounted. The success of this training has been recently exhibited at the camp of Châlons.

11. As before stated, all the improvements in the French cavalry now in progress, must be traced to the experience of the Italian War. The resolution was promptly taken and vigorously put in action. Napoleon III. and his illustrious generals did not conclude that the introduction of the rifle and rifled cannon was a death-blow to cavalry. They came to the deliberate conclusion that, in future, cavalry would be more necessary than ever; that nothing was to be neglected in its improvement to render it fitter for the service which it is expected to perform, either by giving it better horses or by developing the individual instruction of the soldier. Marshal Randon, the war minister, gave directions to that effect, and a committee, composed of the best-qualified officers of the empire, elaborated the various measures which they thought calculated to attain the desired result. From their most important and out-spoken report I shall give the details of the improvements now in progress of application. It will be quite evident, that, whatever may be the deficiencies of our cavalry, it is impossible that they can surpass those of the French when they began the work of improvement. Therefore, if we have much to do, this fact will alleviate the toil of the advance towards a rival perfection.*

"After the conquest of Silesia, Frederick II. directed all his attention to forming his cavalry. He adopted the formation in two ranks, gave it better instruction, its action was more resolute and decisive, and it was confided to the experience and high intelligence of such commanders as Zeithen and Seydlitz. Its brilliant exploits enhanced to a high degree the importance of cavalry.

"Since that period this arm has not undergone any radical reform in its organization; nevertheless, it has passed through different phases. Its importance varied according to circumstances, and its more or less frequent employment. During certain periods it has been raised in estimation far above the infantry; in others, it has received much less consideration. These two opinions, somewhat hastily advanced, were to be regretted. Each arm proves its value—its merits—when we know how to make a proper use of it. Still, it is admitted that an army should have a powerful and mobile cavalry, so that nothing can resist it when it is well organised and led with the tact of experience.

1. "*Modifications required in the Cavalry.*—The improvement in the accuracy and range of rifled arms of the infantry and artillery has given them considerable power, doubling their moral effect, and tending to lessen the impetuous action of the cavalry. It is important, therefore, to follow the same progress, and try to restore its elements of attack and defence by a more rational instruction.

* The Report begins with an interesting historical summary of the cavalry in all times, "from the beginning," which, however, I have omitted, as being beside my present purpose.

"For a long time the radical defect of the cavalry has been its deficient mobility; even at the present day it is not sufficiently exercised to foster a powerful military *morale*, that impulsive dash which performs hazardous exploits. The cavalry is lost in inactivity; its horses are well groomed, fat, but easily winded and blown, and consequently more liable to disease than they would be if they were constantly and in all weathers kept in wholesome activity.

"To preserve the true function of the cavalry, its mobility and action, we must give it, by incessant and varied exercise, that impetuosity and daring which tend at the present time to disappear through the apprehension of wearing out and fatiguing the horses. To distinguish those regiments which have annually lost the fewest horses is certainly favourable to their preservation, but it is pernicious to the maintenance of the cavalry in a state of vigour and mobility.

"Some of the officers are too old or used up. The majority have not that physical vigour nor that noble ardour which is such a precious example to the men. There exists among the superior officers a grievous state of indifference—*un laisser-aller facheux!* It is an epidemic which has propagated itself throughout all the degrees of the service, and which may lead to disorder, utter inability, and discouragement. The pride of the service grows weaker and disappears, and that self-esteem, which produces such great results when it is appropriately excited, is no longer susceptible of that precious enthusiasm which we are sure to find when we know how to appeal to the heart of those whom we command.

"2. *Ill-considered Instruction.*—Our cavalry, however intrepid and vigorous it may be, sins in the essential part—*riding*. It is not sufficient that a horseman can keep in the saddle: he should be completely master of his horse, so as to impress him with his will as easily at the full trot and gallop as at the walk; able to quiet and subdue those horses which are too ardent, and rouse and animate the sluggish. Cavalry must not be only a mass hurled like a bullet at a target—for we must not forget that cavalry charges degenerate into *mêlées*, into hand-to-hand encounters, in which the rider's skill in handling his horse and weapons gives all the advantage. But, to attain this skill, the horsemen must be frequently exercised in open country and on broken ground, then urged to the gallop, and left to themselves; so that, measuring the distances, they may thrust, sabre, and cut at the heads of the supposed enemy. A skilful horseman should be able to turn short, and suddenly halt his charger at the top of his speed, make it turn on its haunches, leap ditches, hedges, and over cross-poles. Two horsemen must also be habituated to run after each other, leaping over the obstacles of the ground, to cross rivers by swimming, and to fire at a target at all the paces, the walk, the trot, and the gallop.

"3. *Recruiting.*—To secure these results we must take care from the beginning to fill the ranks by a very rational method of recruiting. We must select men from the inhabitants of those districts where horses are bred,—men accustomed not to fear horses, used to their management, and the care of them,—men who take an interest in the well-being of the horse. Such are the recruits in whom we shall find the elements calculated to quicken our progress and give good results as cavalry soldiers. On the other hand, a recruit from a hilly country, from a country of vineyards, or

from a manufactory or trade, for a long time looks upon the horse between his legs as an enemy whom he fears,—does not fall in love with him, grooms him badly, and totally neglects those attentions which endear the kind master to his grateful horse.

"The horseman must be vigorous, robust, alert: his strength must be proportioned to that of the horse, and the weight of the arms which he has to use, his stature being about the average; for a tall man on a small horse is as ridiculous as a small man on a large horse. Besides, the former will never ride well, owing to his dangling feet, and will be easily dismounted.

"We must never receive in the cavalry deserters, vagabonds, nor convicts; nor give a horse to a man which would enable him to desert, if we know that his conduct gives no guarantee for his honesty; or to a man whose vicious habits lead us to suspect that he would defraud his horse of its provender.

"4. *Training of the Horses.*—The new horses are not trained with sufficient care; their instruction is not sufficiently progressive and individualised. There is very little coaxing, too much violence and abruptness, causing premature fatigue. The result is that the horse is scarcely under control, but on the contrary headstrong, sometimes skittish and restive: he is not in the rider's hand; it is difficult to master him. But it is absolutely necessary that the horses should be supple, obedient, and trained with all the skill and easy progression so desirable in the agents—the men themselves, whose duty it is to prepare, direct, and inspire them with confidence.

"5. *Instruction of Recruits.*—Having carefully recruited the cavalry, we must, by a methodical education, familiarise the recruit with the knowledge of the material which he is to use, and all the theoretical and practical military notions with which he must be acquainted. We must develop his intelligence by the explanation of the moral duties before acting mechanically on his body. We must win his confidence by frequent questions on what he is taught, devoting a part of his instruction to progressive gymnastic exercises, to render his body supple and yet give occupation to his intellect. We must excite in his heart those sentiments of self-esteem which we can rouse on the proper occasion to achieve great things, and which always facilitate the progress of instruction. We must entice him on by kind words during the lessons. Change in the method of instruction must be avoided; if we would obtain the best results we must constantly insist on the same principles. He must have much individual practice on broken ground, at all the rates of movement, to acquire solidity, to make him acquainted with the qualities of his horse and the means at his disposal.

"When the men are able to manage their horses, continue the instruction with the handling of their arms, first at the halt and then at all the rates of movement; teaching him all the different cuts of the sword, points and parry, according to the position of the opponent whom he would attack, and repeat the same movements at the trot and gallop with the sword and the lance, whilst leaping over obstacles.

"Complete these instructions by carbine and pistol practice, teaching the men how to place their horses so as to avoid accidents. This instruction will make the men and horses supple, and render the latter docile and nimble or less skittish during the sword and manual exercise, and less excitable under fire.

"Conclude with company charges, or charges *en fourrageurs*.* In these charges they will learn how to rally, to regulate the speed of their rates in column or fours, by gradually augmenting the rate, in order to put the horses in wind, without wasting their means of endurance and endangering their preservation.

"This part of the instruction demands special attention, for rapidity in the rate, and regularity in the movements, are the principles of all success over the enemy, and mobility gives the means of taking the initiative and anticipating the attack of our wings by the enemy.

"This individual instruction, calculated to render the horseman more active and mobile, is necessary to avoid, partially at least, the disastrous effects of the infantry fire and that of the artillery, whose arms have so long a range, and whose firing is so much improved.

"6. *Better horses.*—But to obtain this indispensable mobility the horse must be more select, better fed, to aid the dash of the rider.

"Those who have to purchase these horses must be most exacting in their requirements. The horses must combine all the qualities of conformation, strength of limbs, development of organs, and stamina to support the fatigues and increase of labour in the lengthened rates of movement. It is better to pay a higher price than to place in the ranks of the cavalry lymphatic horses, defective in conformation, without sufficient energy to give the chargers that daring which enables them to make those bold dashes which ensure success, and do honour to the service. As we wish to augment the power of the cavalry we must increase the food of the horse.†

* The *charge en fourrageurs* is given in extended order. The old regulation did not require it to be made in perfect order, but permitted each horseman almost to take what direction he pleased. This might be attended with serious consequences. A charge *en fourrageurs*, or extended charge, methodically conducted, that is to say, preserving a certain alignment and keeping up equal intervals between the chargers, would, at a distance, present the appearance of an unbroken line, covering with a few men an extent of ground relatively considerable, whilst giving great facility for leaping over or avoiding obstacles, and permitting the fullest development of individual action. In the ordinary boot to boot charges, a soldier in the second rank is almost paralysed by a bad front-rank man inclined to give in or turn to the right about. It is therefore probable that future charges will be given in single ranks, with plenty of elbow room on either side. Tactics have, from the earliest times, continually diminished the formation of troops. From 32 ranks, its number in antiquity, it has been successively reduced to 24, 16, 12, 10, 8, 6, 4, 3, and now to 2. Analogy would make us infer that we shall ultimately fight in a single rank. Certainly this will diminish the danger of long range, which requires us to lessen the depth of our formations. More freedom of action, and infinitely less squeezing in the ranks, are imperatively required by the soldier to comply effectively with the rifle's rules of firing. The charge will, of course, be made in two ranks; indeed perhaps three ranks would be better still, by increasing the material shock and moral effect, besides the resources of the third in filling up the front and second ranks, in the event of casualties during the advance.

The foot-chasseurs were the first French battalions formed in two ranks, in 1845, but recently this formation has been extended to the entire French infantry. It was only gradually adopted in our army, and a part of the army in Spain, during the Peninsular War, still retained three ranks, when the Duke of York, in 1810, abolished it completely. For the disadvantages and advantages of three ranks, see General Dufour's *Cours de Tactique*, p. 56, *et seq.* It is said that the Duke of York's object in adopting two ranks was merely to get a more extended front.

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from a manufactory or trade, for a long time looks upon the horse between his legs as an enemy whom he fears,—does not fall in love with him, grooms him badly, and totally neglects those attentions which endear the kind master to his grateful horse.

"The horseman must be vigorous, robust, alert: his strength must be proportioned to that of the horse, and the weight of the arms which he has to use, his stature being about the average; for a tall man on a small horse is as ridiculous as a small man on a large horse. Besides, the former will never ride well, owing to his dangling feet, and will be easily dismounted.

"We must never receive in the cavalry deserters, vagabonds, nor convicts; nor give a horse to a man which would enable him to desert, if we know that his conduct gives no guarantee for his honesty; or to a man whose vicious habits lead us to suspect that he would defraud his horse of its provender.

"4. *Training of the Horses.*—The new horses are not trained with sufficient care; their instruction is not sufficiently progressive and individualised. There is very little coaxing, too much violence and abruptness, causing premature fatigue. The result is that the horse is scarcely under control, but on the contrary headstrong, sometimes skittish and restive: he is not in the rider's hand; it is difficult to master him. But it is absolutely necessary that the horses should be supple, obedient, and trained with all the skill and easy progression so desirable in the agents—the men themselves, whose duty it is to prepare, direct, and inspire them with confidence.

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"7. *The Harness.*—It is essential to look to the harness, in order to enable the horse to move with ease and display his strength, without risk to his safety. For this object we require a light saddle, so made as to be easily kept in order and repaired, and well adapted to the conformation and structure of the horse. This difficult problem has long occupied the attention of cavalry officers. Opinions are divided as to the necessity of padding the saddle-bow to attenuate the contact of the hard parts in the back of the horse. The shape of the saddle-bow also excites controversy. The Cavalry Committee, impressed with the importance of the question, commissioned General Gudin to study and compare the harness of all foreign nations, and contrive, with the aid of the different systems, a model to satisfy the required conditions, namely, lightness, solidity, admitting of being easily and cheaply repaired during a campaign, and, above all, comfortable to the rider, without inconveniencing the horse. In fact, if the man is ill at ease he cannot maintain his regular position; he leans to ease the fatigue; he does not connect himself with the movements of the horse; his daring and dash are diminished. The conditions of solidity in the saddle are indispensable, to enable him to guide and master his horse.

"The General's investigations, and his conscientious studies, have produced good results, and a sufficiently complete solution of this important question for the cavalry. It is probable that a harness so thoroughly adapted to the conformation of the horse will not produce those disastrous saddle wounds which we had to deplore during the Italian campaign.

sentiments which sustain the soldier in his painful march and struggle in the field, are totally wanting in the horse; the horse has no idea of glory; the work we get out of him is the entire result of our care for his welfare, and the condition in which we place him.

"Military equitation is the union of the theoretical and practical knowledge of the horse applied to military exercises and labour. To become a good horseman, fit to instruct, we must be able to discuss all that concerns the conformation of the horse, his structure, and the work we can get out of him.

"Instead of being superficial, this study should be deep and accurate. We must be cognisant of the exterior and interior of the horse, his use, the best mode of ensuring his health and vigour, the various points that must be attended to in rearing and selecting him for service. This study must be pursued in three points of view: the knowledge of the animal, his preservation, and equitation properly so called.

"Although certain generalities should only be succinctly pointed out, there are important parts of the horse's anatomy the knowledge of which is indispensable. Its osteology—the framework of the basis—serves to show the action of the articulations which concur in locomotion and equilibrium. Its myology—science of the muscles—shows the cords that impress the movements and constitute the mass of the animal. The nature of the internal organs, such as the brain, the basis of its intelligence and sensibility; the lungs, of respiration; the heart, of the circulation; the stomach and the intestines, of digestion,—should all be known by every cavalry officer who cares for his horses, at all events to a certain extent, if not as deeply as by the veterinary surgeon. An officer may be called upon to certify the death of a horse; he must, therefore, be able to state the cause.

"In the matter of the horse's preservation, in health or disease, we must study the general causes that influence his temperament, the nursing he requires, the nature of the air, water, the effect of the seasons, the changes of temperature; the barracks, and their construction; the compartments, the keeping and cleanliness of the stables, and the means of preserving them in a wholesome condition; the different kinds of food considered in their effect on the organization of the horse; forage, the mode of collecting, preserving, preparing, and selecting it. In fine, a thorough knowledge of all the 'points' and defects which give or depreciate value in the horse."

Then the experience of the officers, with more attention to their duties, and conscientious self-respect, will aid these improvements, in order to avoid a great number of those mishaps which we must attribute to want of superintendence.

"8. *Function of the Cavalry since* 1814.—Certain officers, not of the cavalry, have considered its action as likely to be only accessory in the operations of future war. Indeed, all the success it has obtained in our modern wars in Africa have only been isolated encounters—a few razzias, whose only result was to prove to the Arabs the mobility of our cavalry, and the good service we can obtain from brave, resolute, enterprising, and well-mounted horsemen.

"Since the first Empire there has been no cavalry action which can be cited as having produced any results of a nature to influence the duration of a campaign against disciplined troops. The function of the cavalry in the Crimea and in Italy was, so to speak, absolutely null, either on account of the nature of the ground, or mismanagement—*l'incertitude de la direction.* General D'Allonville had a smart affair with the Russians near Eupatoria, but without important results.

"It would have been better, during the Italian campaign, to unite the cavalry divisions of the army in the hands of a single, vigorous, resolute commander, thoroughly impressed with the duties he had to perform, and who would not have shrunk from the responsibility of his mission, instead of dispersing it amongst the different *corps d'armée*, where it was under the orders of officers who were strangers to its tactical handling. The cavalry would have won a lustre before which all the other arms would now incline with approbation.

"Having called to mind the services of the cavalry in ancient and modern times, when it has been opportunely and properly led into action, we have examined the improvements which must be introduced in the nature of the horses, recruiting, the instruction and harness of the cavalry, in order to raise it to the level of the progress made by the other branches of the service, and dispel the sort of disfavour under which it labours with regard to its employment and utility in armies.

"The principal object of an army being to give battle, the action must be planned according to the topographical distribution of the ground of operations. If the battle is in a plain, the most important part is played by the cavalry. If the latter is badly engaged, it is very rare that the army is not defeated. If, on the contrary, it is well led, and gains an advantage, the battle is probably won, and the success is rendered complete in all its results.

"When the army is weak in cavalry, it should occupy the heights, entrench itself, and wait for re-inforcements, as did Gustavus Adolphus in abandoning the plains of Poland and retiring into Prussia. But, whatever may be the theatre of war, the different kinds of cavalry are always necessary to strategical operations. In all cases, it is essentially important to confide its direction only to commanders of great experience, and especially to avoid parcelling it out, and placing it under the orders of infantry officers, who, in spite of their military education, do not habitually employ it usefully when the occasion presents itself, and know not how to spare it when its aid is unnecessary.

"We shall now endeavour to point out, by a new system of tactics, the means to be employed to avoid the disastrous effects of the improved fire-arms, and the different preparatory dispositions for attacking the enemy,—the cavalry charges, and their effect.

"9. *Raking Charges—Charges Rasantes.*—We believe that we must modify the means of attack, and plan them so as to lose as few men as possible, and with this object, instead of direct charges on the faces of a square or on a deployed line, we must, at full speed, execute raking charges, presenting the right hand to the enemy—the horsemen breaking individually at intervals of two yards from each other, at the top of their speed, for, should they slacken pace or stop, they would be soon decimated by the balls of the infantry. We must rake the enemy's line at very close quarters, and threaten the eyes of the foot soldier with the point of the sword or the lance, so as to make him come to the parry by raising his bayonet.

"Companies, squadrons, or whole regiments executing such charges, will inflict immense damage upon the infantry, without themselves sustaining notable losses; for, armed with his sword, the horseman can deliver point through a raking space of from 60 to 80 yards.

"From these data, we can calculate how many horsemen must be placed in file in order that the foot soldiers charged by them may be killed or disabled.

"Nevertheless, these raking charges must be executed only by horsemen completely masters of their horses, and skilful in wielding their sword.

"We must never forget that men must be required to do only what they can do well. They will always boldly undertake to do what they are sure they can do. If they are not sufficiently trained it is important not to expose them uselessly. We must spare them, reserve them for circumstances offering a chance of success, and give them the opportunity to win distinction which will enhance their dash, invigorate their hopes, and confirm their resolves.*

* Of all French conceptions, so wonderfully fruitful in resources, this last method of cavalry attack is decidedly the most brilliant, and it demands our most serious attention. Of course it presupposes the utmost training in man and horse. There can be no doubt, however, that it will be put in practice by the French cavalry, being precisely the sort of work suited to their fiery nature. It is impossible to underrate the moral effect on the infantry squares of such a mode of cavalry attack; the stanchest might well quail for a moment in such a dreadful onslaught. Yet, doubtless, we shall be conceitedly told that the standing ranks will "pour in a deadly volley," and easily settle the matter. With what aim? But even then they will have scarcely more than the chance of their preparatory loading. They may topple over a few of the first chargers; but, by the very proposition, whole squadrons and regiments will follow up the move in this hideous succession, and give no time to load again. And then the rapidity of this raking charge—the rush of the steam-engine or the whirlwind re-produced, strewing destruction on its path!

The only remedy is the utmost skill in the use of the bayonet, with the utmost practice in the appropriate parry for such an encounter, if we retain the old formation of squares, presenting the parallel front on which this mode of attack is founded.

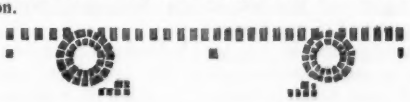
But the most effectual mode of paralysing this new system of cavalry-attack is the French formation of solid circles. For it will be very difficult, if not impossible, for a horseman to deliver effectual point, at the top of his speed, with one hand, whilst the other must direct his horse continually inwards round the circle. The most skilful circus-rider will find it difficult to keep his seat in such a manœuvre. Still, the French cavalry is assiduously practised in the "outwards about wheel," circles and curves in great variety, apparently for the raking charge against any formation whatever. If our usual square be retained, I apprehend that, against this contemplated raking charge, the threatened face should make a left half-face, thus bringing their bayonets in position, with the

"10. *Charging by the Angles.*—The method of charging by the angles is more advantageous and less murderous. It may happen that the cavalry is required to attempt a charge on a deployed line or a battalion in square at the commencement of an action, when the rifles are in full power, and

proper slope, and that the face opposite to the direction of the charge should make a right half-face, so that the standing ranks may fire on the advancing cavalry. As this face is not immediately threatened, it will probably deal deliberate and effective shots on the "raking chargers," if it does not fire too soon. On the other hand, this mode of charging confirms still more the opinion in France, that small squares are better than battalion squares. A horse killed in the charge frequently does more damage than his rider, by tumbling on the extended face of the great squares, whereas he might miss the men in small ones, and fall on the flanks. Besides, the latter are more quickly formed. Of course the case is different in such battles as Napoleon's at Gizeh, and Dessaix's at Sediman—both models of formation against preponderating cavalry; but even herein the great squares were flanked by small squares, at the angles especially. The following is the French method of forming the solid circle in skirmishing-drill. "By sections—rally." At this command the leaders of sections run quickly to the centre-group of their sections, or to another group more inwards, whose position offers shelter, or an advantageous position; the skirmishers run together at full speed, without distinction of numbers upon that group. The men composing the groups which are the bases of the movement, instantly form square and raise their rifle, the point of the bayonet over head, in order to indicate the rallying point. The other skirmishers, as they come in, place themselves at the angles left vacant between the four first, and successively round this first nucleus, so as rapidly to form a solid circle on the primitive square. The outer rank comes to the position "charge-bayonets" standing, the point of the bayonet more elevated, and full cock the rifle. When the movement is completed the two outer ranks load without stirring, and make the best defence they can.

"The officers and non-commissioned officers must see with the utmost attention that the rally is performed in silence, with the utmost promptitude, and without confusion, and the firing be properly directed so as to be efficacious."

The following woodcut shows the *solid circle*, the third concentric ring being in the course of formation.



If the shock of infantry charging is far more a moral impression than a physical pressure, how much more efficacious in that respect must be such a raking charge as intended! We know that in battle the eyes are the first to be conquered, *in omni prælio oculi primi vincuntur*, and we say that "the contest is merely a moral one;" and so we must render ourselves familiar with the "idea" beforehand, and be ready to bear its brunt in practice, and render it null and void, if we can, by a steady eye, firm foot, and unflinching resolution.

The formation of the solid circle is from the "Ecole de Tirailleurs," of which it has been truly said, that "nothing more simple, succinct, and to the purpose, can be desired than these 40 pages in 16mo. of which a good portion are 'observations.'" The great innovation is the grouping in fours, which forms the manœuvring unit, and the idea is carried through. It is this skirmishing brotherhood which forms the basis of the whole. They are taught to consider themselves as so many groups, and are left to their own discretion in rallying. The nearest group and the shortest way is the rule. These groups are, as it were, intermediate links between the single skirmishers and the whole body of skirmishers. Whoever saw or did skirmishing knows the value of this, especially in the rallying to resist cavalry or foragers. There is not much question of the right and left as immovable points; but right is right, and left is left, with regard to the direction in which the movement is to take place. The circle is extensively used as the simplest form of rallying the groups of four in larger ones. This idea is said to be American, but I believe it to be essentially French.

The squares are formed on the same principles as in the large evolutions, and these principles are the simplest. If in column of divisions of two companies the distances between them are reduced, the first and fourth remain in their places, half of the second faces right, the other half left, the centre sections of the third remain as reserves, while

the *morale* of the men is untried. The horseman, armed with his sword or his lance, falls upon the foot-soldier armed with his rifle. If the latter were isolated, his movements would be free—he might turn and deliver his bullet into the breast of the horseman; but, instead of being isolated, the foot-soldiers are packed together in a line, or framed, as it were. Whatever the number of the horsemen, there are always four or six foot-soldiers to one horseman, according to the depth of the ranks, and the latter will be exposed to four or six bullets instead of one, which he can avoid, at the angles, by the velocity of his raking charge.

"11. *Posting of the Cavalry-reserves in Battle.*—It is only by a well-considered individual training that we can secure a vigorous and dashing cavalry. In battle we must avoid keeping it in masses too near the infantry. The deep ranks of a close column have, it is true, the advantage of uniting the troops and reserves, and enables us to dissimulate their number; but such a disposition in the presence of the fire-arms now in use would cause immense misfortunes, and damage the *morale* of the cavalry by losses which it would be difficult to repair. To conciliate the matter, it is therefore important to form several columns at deployment intervals.

"We do not manœuvre much in war. The simplest movements are the best. Skill consists in seizing the opportunity by the forelock. We must attack the enemy on his weak side, take advantage of the least fault he makes, and fall upon him when he is deploying.

"It is essential to study the enemy's situation, shake his *morale* by the effect of our artillery, especially when he is in position or covered by obstacles. We must endeavour to surprise him by the rapidity of our attacks. In the front of the squadrons we must always be preceded by scouts on the right and the left, at the distance of 50 or 60 paces, to reconnoitre the ground of operations.

"Cavalry charges must be prepared beforehand in order to succeed. It is therefore the general's duty to get exactly acquainted with the nature of the ground. A mere nothing suffices to ensure their failure; an inequality of the ground, a bad direction, the incapacity of the leader, the exhaustion of the horses, the tumult, the effects of artillery, the discouragement resulting from a succession of failures, &c.

"Charges may be made in line, in column, in echelon, and in extended order *(en fourrageurs)*.

the flank sections face right and left. If the front is only one company, an oblong square is formed by the first and last company remaining in their places, and the rest, with the exception of the seventh, forming the reserve, facing right and left. The most remarkable and important part, then, of the new infantry instructions is the part relating to skirmishing, which would be worth a translation and study if only on the part of the Volunteers, although many hints might be likewise derived for the primary instruction from the "Ecole du Soldat." It is less stiff and more adapted for Volunteers, who surely would not like to be considered as machines. Perhaps our formation of square is scarcely quick enough in the present eventualities. When in danger of cavalry a company could form effective square to the simple words, "Fours-deep—cavalry—ready," and save precious time. A company marching in fours is already in position to form square. More backs would thus be felt, and there is nothing like feeling a back when on the defensive. The square-formations are amongst the most important "developments" of the new French battalion-drill: there is one particularly worthy of study, "Column against Cavalry." See "Ecole de Bataillon," p. 205. The last company but one always acts as "reserves" to the squares. It is said that four successive and well-directed discharges, from four ranks, will stop the best cavalry.

"The chief object is to fall suddenly and obliquely on the flanks of the enemy, masking the movement with a curtain of light troops in a single rank. These sham attacks, especially if veiled by a cloud of dust, threaten the battalions against which they are directed. It may happen that infantry, without experience and untrained, gets disconcerted by these movements, fires at random on this curtain, whose thin line nullifies the effect of most of the shots, hurriedly reloads, does so in disorder and with agitation, thus presenting a splendid chance of a murderous charge, especially if charged by heavy cavalry.

"11. *Speed of the Cavalry charging Artillery and Infantry.*—Numerous exercises have shown by favourable trials that we can estimate the advance of cavalry according to the following data. Fixing the precise point where we may begin to charge at 550 metres (about 600 yards), a light-horseman advancing against a battery, first walking, then successively at the trot, the gallop, and the charge, will be up in 2 minutes and 24 seconds, arranging his rates as follows:—95 seconds walking, 28 at the trot, 13 at the gallop, and 8 at the charge. He will have done the distance at the rate of about 4 yards per second, and during the same time (2 minutes and 24 seconds) the battery might fire 13 shots of 6-pounders.* The same horseman doing the distance without the transitions will only take 113 seconds, which gives 5 yards 15 inches per second.

"If we apply the same researches to the charge against infantry, we find that the horseman, commencing it at 370 metres (about 400 yards), does the distance in 50 seconds, receiving three shots, and with the speed of nearly 8 yards per second.

"It is important to remember that the sword-point exerts its effect at the distance of 25 inches, whilst the bayonet does not project in front of the soldier more than 20 inches when in position against cavalry charging.

"It is a pity that cavalry officers remain indifferent to the study of these important questions, and it is desirable that experiments should be tried at the camps of Châlons, Versailles, and Lunéville, in order to transform into precepts the data of experience.

"12. *Charges against Infantry and Cavalry.*—Charges against infantry and cavalry have the same object, namely, to rake, to penetrate the troops against which they are directed. It is essential to seize the opportune moment—a deployment, a retreat, a crossing of a defile, an obstacle forcing a reduction of the front, and to act with such cohesion as will break through all resistance.

"13. *Charges against Artillery.*—The case is different with artillery. These charges are performed by the individual movement of a line of horsemen dispersed in extended order—*en fourrageurs*—presenting to the enemy only scattered men, but all making for the battery to take it in the front, on the flanks, in the rear—at the same time—with the utmost dash and impetuosity. They strive to turn the positions, to attack the supports by their weak side, to harass their retreat, shake the morale of the drivers, cut the traces, spike the guns if they cannot be carried off, using a small hatchet-hammer—in fine, employing all means to silence and shut up that battery completely.

* The French rate their howitzers, &c. according to the diameter of the ball—but the measure may be taken as the weight in *lbs. Eng.*

"This mode of attack will prevent the great loss usual on such occasions, by avoiding that agglomeration which presents a good target for accurate practice,—for, let us suppose that a column of twelve men in the front and fifty deep is hurled against a 12-pounder, served by twenty gunners. Before it is reached, these gunners will have delivered sufficient balls and grape to upset a portion of their adversaries, whereas, twenty-five horsemen in skirmishing order, at intervals of 25 or 30 yards, will certainly get up to the gunners without having suffered much in the rapid advance."

These few remarks on artillery seem to be less than the subject demands: I will therefore submit the following observations to supply the deficiency of the Report in this important matter, suggested chiefly by General Bonneau du Martray, Chef d'Escadron, &c.

Field artillery has hitherto been a costly, heavy, embarrassing arm, difficult to restore when once destroyed; and, moreover, it has as often hampered the troops with which it operated as it has been useful to them, for, on its account, it has been necessary to follow directions, to select ground, and to march at rates unfavourable to the troops. Whatever may be the vigour of the horses, as soon as the carriages meet with marshy ground and hollows, slippery slopes or roads covered with snow, it advances only at a slow rate, and with immense difficulty. A check to the advance is almost as bad as a defeat on the *morale* and *physique* of an army.

Very often the other arms, instead of receiving support from the artillery, have been obliged to sacrifice themselves to save it; and, for a false point of honour, they have paid with the lives of a great many brave men, for the preservation of a few pieces of bronze, which, however, they have been forced to abandon a little further off—a sterile trophy indeed, but still sufficient to puff up the pride of the enemy.

Now, if the only object in view is to place men *hors de combat*, cannon is decidedly inferior to the rifle. To appreciate the effect of an arm, we must consider not only the accuracy of its fire, but also the time required to load it, as also the number of soldiers, and all the accessories of its service. Thus, a light 12-pounder, which requires in the field, for itself and its caissons, about thirty men and thirty horses, scarcely fires, amidst the complications of battle, one shot per minute, and at 650 yards hits an object of middling size only once in four discharges with ball, or with five bullets out of forty of grape. Consequently, taking as unity the damage done to the enemy by one discharge of grape, and admitting that the ball produces four times as much damage as the grape, we arrive at the conclusion that the effect of the piece in question is represented by one for the discharge of ball, and five for the discharge of grape, in a minute. Now, during the same time, thirty foot-soldiers would fire at least sixty bullets, of which one-fourth, or fifteen, would hit the object in question. It follows, therefore, that the useful effect of the rifle would be represented by fifteen, that is, it would be treble that of the grape and fifteen times greater than that of the ball. Moreover, all other circumstances being equal, we should economise thirty horses and four carriages.

The conclusion is, that cannon must be used only to break down or knock over obstacles—to fire especially at great distances—to act as reserves, and then to act in powerful batteries, to fill up an accidental void

in the order of battle—or to fulminate an enemy victoriously advancing after having crushed or overwhelmed the other troops.*

Artillery, moreover, must be placed in very favourable circumstances, out of which its efficacy is considerably diminished, or is totally nullified; for instance, when it cannot, without a considerable roundabout turn, reach the points whence it can discover the enemy—when the latter is posted too high or too low with reference to the horizon of the guns—when the ground permits too much recoil—when the horses and gunners are killed. On the other hand, the soldier with his rifle goes every where—scales the heights—crosses ravines and rivers—glides into the midst of bushes and copses—avails himself of trees and rocks by way of shelter or support to take better aim—can give to his line of sight all the inclinations from the zenith to the nadir—in fine, can profit by every thing that would absolutely be detrimental to cannon.

Again, skirmishers easily destroy artillery. In the last continental wars, the range of the musket being very short, the infantry could not struggle against artillery when the latter attacked it at five or six hundred yards. It will not be thus at the present day. Suppose six pieces endeavouring to place themselves in position: they will occupy a pretty wide extent of ground, and will present in this extent six considerable groups of men and horses, on which it will be easy, with middling skill, to rain bullets. Fifty skirmishers at sufficient intervals, so as to present but a very small target to the battery, would fling, in five minutes, 500 bullets, one hundred at least of which would hit those large targets of men and horses and tumbrels to their utter disorganization and confusion. A striking experiment of the sort was tried at Hythe on the representation of a battery coming into action. Thirty men were arranged in skirmishing order, and fired at a group representing a field-piece coming into action—stuffed figures of horses and men of the ordinary size. The firing was stopped at two minutes, when it was found that each man had fired two rounds. There were six horses and eleven men, including the three mounted drivers, and the six horses had twenty-two bullets in them, and seven of the men were struck. The trial was repeated at 815 yards; five out of the six horses had sixteen hits, and six out of the eleven men had eight balls. At this second trial the time was extended to three minutes, when it was found that the front rank had fired three rounds, and the rear rank two.† The length of the time indicates that deliberate firing which we shall expect from our skirmishers. Colonel Jacob says:—"Judging from our practice, it seems certain that two good riflemen so armed [with his rifle, I presume,] could in ten minutes annihilate the best field battery of artillery now existing." And the feat was accomplished at the battle of the Alma by the French, where several Russian batteries had to be removed, the gunners and horses being quickly killed, so that it was neces-

* It is seldom that the ground presents a sufficiently even surface to permit cannon to fire further than the rifle when firing effectively at 750 yards; at this distance slopes and obstacles often conceal from sight not only single men, but entire bodies of troops; or, we are unable to get that inclination of the axis of the piece which is so essential to ensure good results.

† Col. Wilford's Lectures, p. 7.

sary to fetch other horses to draw off the guns. In one hour and a half the French skirmishers utterly smashed the Russian gunners. "They came upon us like serpents, and killed our men without our being able to see them," said the Russians. The Turks did the same with the Russian artillery on the Danube with the Minié rifle at 1,000 and 1,200 paces.*

If the distance diminishes and the affair is prolonged, the chance increases more and more in favour of the skirmishers, who will repair their losses from their reserve, whilst the intensity of the fire of the guns will sensibly decrease just in proportion as their men are knocked off. It may be objected that the enemy will disperse his foot soldiers between his pieces, to fight the skirmishers; but then this will only increase or double the disadvantage, by presenting thicker groups to be fired at, whilst he has before him only isolated men, defiling into the smallest depression of the ground or behind the smallest obstacle; and, moreover, raising before his skirmishers the thick smoke of his cannonade, which will prevent them from aiming effectually.

The proportion of field artillery must be less than heretofore. The best conducted campaigns of our century and the last were carried on with few guns relatively to the strength of the armies; but in 1809, in proportion as good troops had disappeared, mowed down in battle, it was tried to supply their place with artillery, which increased in considerable proportions, and in 1813 its importance still more increased when the cavalry and infantry had only conscripts in their ranks. During the first years of the conquest of Africa, the expeditionary columns dragged field-pieces after them. The result was a slowness or retardation of the march most prejudicial to the peculiar strategy required in dealing with the Arabs. At the camp of Tafna, where a French division was blockaded by Abd-el-Kader, the French durst not send out a fatigue party to the woods or to forage without the escort being accompanied by cannon. Marshal Bugeaud, then brigade-general, was ordered to leave France to put an end to this frightful state of affairs. At his arrival, in spite of the representations of several superior officers, who maintained the old theory of the moral support given to the troops by artillery, he shipped off the artillery which was in the camp so as not to fetter his ulterior movements: then advancing with confidence against the Emir, at the head of the infantry, but lately full of alarm and discouragement, he won a complete victory at Sickak. Some years after, having become governor-general of Algeria, he used in his expeditions only mere mountain howitzers, and those in insignificant numbers.

What Marshal Bugeaud did in the African war we must henceforth do in all wars, and reduce the proportion of field-artillery hitherto admitted in our armies, because its relative efficiency is diminished, and because the liberty of moving easily on ground the most broken and bereft of communications, will always be an advantage to be preferred to all others. Doubtless this species of artillery is, like the rifle, susceptible of immense improvements; breech-loading, rifling, elongation of the projectile, diminution of weight, fewer men and horses, are improvements on the point of

* Baron Rostaing proposes to give the artillerymen *chevaux de frise*, consisting of six bayonet-blades, and quite portable, so that they may be able to return the fire of the skirmishers at an advantage, after spreading out before them their *chevaux de frise*. See his "Nouveau Système Militaire," where he describes his invention.

passing into the domain of practice, and, consequently, they uphold the preceding proposition, since with fewer guns we shall obtain better results.

A single gun, at the most, to one thousand men, infantry and cavalry, will suffice in future;—such is the deeply meditated opinion of General Bonneau du Martray.*

"14. *Heavy Cavalry.*—We must now examine the function of the heavy cavalry, that of the light cavalry, and their respective employment, according to the nature of the country in which we are operating.

"Heavy cavalry, which comprises the Cuirassiers and the Dragoons, must act in battle to break down resistance by the force of its shock; its place, therefore, cannot be supplied by light cavalry, whose mass is less considerable. Thus, at the Battle of Austerlitz, the light squadrons of General Margaron were checked by the Austro-Russian squadrons, whilst Boursier's Dragoons repulsed the latter, and presented an impenetrable wall to the enemy's attempts. At the same battle a similar fact occurred in the grand charge against Lichtenstein's squadrons in the centre; the Chasseurs of the Guard—that intrepid troop of veterans—tried to stop the advance of Prince Repiren; they were routed and thrown into confusion, but only to be very soon avenged by the Horse Grenadiers, who gallantly extricated them by their weight and intrepidity.

"15. *The renown of the Heavy Cavalry under the Empire.*—The reputation of the heavy cavalry was as well established amongst strangers as in the French army. Bismarck declares that the soldiers of the Empire, when they would honour valour, used to say, 'Brave as our Cuirassiers.'

"Wellington himself declared at the Congress of Verona that he had never seen anything more admirable in war than the ten or twelve reiterated charges of the French Cuirassiers against troops of all arms. Later, after having had to support the efforts attempted with so much intrepidity and perseverance at Waterloo, he declared that no cavalry could surpass it. In 1808, at the siege of Saragossa, General Palafox issued a decree, awarding death to every Spanish soldier who should, in the sorties, cry out, 'Here are the French Cuirassiers.'

"16. *False ideas expressed on the transformation of the Cuirassiers.*—The Dragoons had equally won an imperishable renown in Spain.

"The valour of the heavy cavalry does not weaken in any degree that of the light cavalry, whose employment is equally brilliant, equally glorious in war. Each has its merits; it would, therefore, be unjust to cry up one at the cost of the other. It is important to refute the ideas put forth by certain innovators after the Italian campaign, without any foundation, since the cavalry was not permitted, by action, to challenge a judgment on its services. The transformation of the Cuirassiers into Chasseurs, somewhat lightly conceived, would be very imprudent as a moral effect and as a material effect on the constitution of the army. Instead of permitting these suspicions of contemplated reduction or transformation to float about, to the disquiet of the officers, let us preserve what we have, and, like our neighbours, who respect more seriously the

* Nouvelle Méthode de Guerre, p. 10. A very curious pamphlet. It was printed for private circulation, only three or four copies being on sale at an exorbitant price. I may have an opportunity of giving the General's views of the order of battle he proposes to meet the requirements of the rifle and rifled cannon.

well-calculated elements of their armies, let us occupy ourselves in the pursuit of improvements to be introduced.

"17. *Function of the Light Cavalry.*—The light cavalry has been called 'the illuminating torch and the protecting shield.' Its place is everywhere—at the outposts, in the main guard,* in patrols, skirmishes, reconnaissances, surprises, flank movements, diversions; as an advance guard, and as a rear guard, where it is supported by the heavy cavalry; in engagements of cavalry, where, in its turn, it acts as a support and reserve to heavy cavalry, whose victory it completes, by pursuing the routed enemy, or whose retreat it protects, by attacking and surrounding on all sides the victorious squadrons.

"In battles in an open country the services of light cavalry united to infantry are equally important. If the divisions of the cavalry reserves do not stir before the moment fixed by the general-in-chief, on the other hand the leaders of divisional cavalry must be allowed the greatest independence. Their action is intimately connected with surprises and *coups de main*, when the lucky moment vanishes like lightning.

"To protect the skirmishers of the line and disperse those of the enemy; to keep an eye on the batteries of the division and seize every favourable opportunity to make a dash on those of the enemy; to support the flanks of attacking infantry on the offensive, and on the defensive to be ready to sacrifice itself, if necessary, by rushing on the enemy's infantry to check its advance, if but for a moment; such is the noble and hazardous function reserved for the light cavalry, as performed by Desvaux's division at Solferino.

"This function of the Hussars and Light Dragoons will be enhanced by the mobility of infantry and the increased range of the rifle and rifled cannon. They are often flung out to great distances and in small detachments. They keep their eyes on the movements of the enemy; nimble, active, audacious, they penetrate everywhere. They should be endowed with the instinct and intelligence of the trail-hunter, the craft of the poacher, the intrepidity of the fillibuster. Without a tolerable and sufficient light cavalry generals must march like blind men, and armies will be compromised. For such a service we must select special horses—active, full of nerve, light and impetuous—to suit their riders; † but there is no necessity for breeding them for that purpose, as required by Captain Nolan.

"To have this mobility, the light cavalry must be mounted on fiery, active, perfectly manageable horses, full of nerve and broken into all manner of service, and endowed with such vigour of constitution as to be able to resist all changes of weather and endure privations and fatigue. Perhaps it would be dangerous to employ the Cuirassiers and even the Dragoon horses in this service, which would soon exhaust them. Each arm has its value according to its employment. Indeed, with equal *morale*, a regiment of Cuirassiers or Dragoons will always crush a regiment of

* The outposts are divided into *postes avancés* and *grand' gardes*, the former being further out, the *grand' gardes* being their rallying point and centre. The outposts are supplied by the *grand' gardes*, which I translate by *main guard*. In the great continental armies these matters are of the utmost importance, as they should be indeed in every army in the field.

† As this section has been borrowed from General Renard, I have translated the passage from his book, *ubi suprà*, p. 113, *et seq.*

Chasseurs or Hussars; but, on the other hand, the function of the heavy cavalry could not give decisive results without the aid of the light troops. It is therefore necessary, in good tactics, to marry these two arms, and combine the strength and weight of one with the impetuosity and lightness of the other.*

18. "*Necessary qualifications of a Cavalry Commander.*—To command and handle cavalry exacts long study and experience; but to manage it so as always to have it in condition to act, is the object which few officers can attain. It is a rare thing to find combined the qualities of cool determination, *sang froid*, with impetuosity, in the same individual. According to circumstances, we may carry too far the tendency to abuse the mobility of cavalry, and compromise it by ill-planned marches, or by inopportune charges.

"At the battle of Leipsic, Murat's cavalry, exhausted by superhuman efforts, had halted panting before the marshy ground of Gulden-Costen; it was without infantry, and had not a single squadron of reserve to oppose to the attacks which threatened its flanks. The exhausted squadrons were attacked by the Austrian Cuirassiers, charged on the left by the Cossacks and the Hussars of the Russian Imperial Guard. Murat was forced, after considerable loss, to retreat upon the lines of the infantry. At Waterloo, the English infantry, after having resisted the charges of the French Cuirassiers, was disengaged, and, supported by fresh squadrons held in reserve, hurled opportunely into the intervals of the first line. These two examples, at different points of view, prove that we must not abuse the rates of motion, and that it is imprudent to exhaust the strength of the horse before the decisive moment; for a troop, preserving a regular, moderate rate of motion, falls upon the enemy with union and impetuosity, and at the last moment will be able, by its strength and cohesion, to overturn and complete its destruction.

"The regular and long-continued trot and the impetuous gallop are the

* We give the straight sword to the heavy cavalry because it is best adapted to give point forward in charges in line; the light cavalry, having to fight for the most part in extended order, is best armed with the curved sword, with which they can more easily cut right right and left, and whose handling for the parry is easier and more decided. To give point, however, should be the object of the cavalry; cuts are rarely decisive. With regard to the lance, only the best trained horsemen can use it to advantage, if at all. It requires great skill and vigour in the horseman, and great suppleness in the horse. In our western regions, only the Polish and Cossack horses have the requisite qualities; the consequence is that good regiments of lancers are rare even in armies of the most lengthened service.* Still this arm has often been of most important service: hence Montecuculi called it "the queen of armies," *la lancia è la regina delle armi*; and Marshal Saxe assigns the lancers the first rank. Certainly the lance will reach the foot-soldier who can brave the sword in security. In 1813, at the battle of Dresden, a division of Austrian infantry resisted for a long time the repeated charges of the French cuirassiers with their bayonets alone, for the rain had damaged their cartridges and they could not fire. General La Tour-Maubourg placed at the head of the last charge the 50 lancers of his escort; they made a breach through which the cuirassiers entered, and cut the infantry to pieces. In 1811 Napoleon had ordered a regiment of lancers to be attached to each division of cuirassiers, apparently in contemplation of similar occasions. Dragoons were first created in Italy by Marshal De Brissac: he had armed them with the infantry musket to fight on foot, the horse being only a means of rapid transport from one point to another.

* General Dufour, *ubi suprà*.

rates of the cavalry in troops; the very rapid trot and short gallop are the rates of isolated cavalry. *

"19. *The Influence of the new Arms on Tactics.*—The improvement in firing, and the range of the new arms, will have great influence on tactics.

"The lines of reserves must keep at greater distances; the deployments of columns must be done with greater prudence; column marching must be at wheeling distance, as a rule; skirmishing will assume more serious developments; all diversions and turning movements will require a greater radius.

"The bivouacs must be covered by outposts of cavalry as a protection against batteries that might shell them, for, the greater the distance between opposing armies, the more cavalry and light artillery will be

* Elsewhere in the "Miscellanées Militaires" I find other very pertinent observations:—

"The chief staff-officer of a *corps d'armée* who does not know how to calculate his marches, and who is imprudent enough to move off, at the same hour and by the same route, united masses of troops, ruins and quickly destroys his cavalry. The result is the same when a cavalry division is obliged to regulate its march, in a broken and difficult country, at the same hours of departure as the infantry; it is soon reduced to nothing by its injured horses, diminishing its fighting effective.

"Experience has proved that a well-led cavalry may still lose a quarter of its effective for action; but this loss amounts to a third if it be led with only middling capacity, and it may rise to the half, or even more, if the leader is incompetent.

"Officers capable of leading adequately this arm, so complicated in all its bearings, are rare. They should unite to a variety of knowledge a special and profound study of its elements and wants, in order to keep it in condition.

"With all this knowledge, the leader of cavalry must possess a prompt *coup-d'œil* to seize the opportune moment of a probable success, and a ready judgment to weigh the favourable chances of a movement or a determination, and foresee the obstacles of the ground that may impede his design and frustrate his action, if not cautiously avoided.

"But even these qualities are not sufficient for success; he must be full of daring, and yet deliberate, or these characteristics must be so blended as to be, on occasion, equally within his control. In certain circumstances the commander's audacity wins the day; but, on the other hand, when in excess, it may entail disaster. If, however, he is too prudent, too deliberate, he is condemned to negative results in a campaign.

"Without the action of a good cavalry, in good condition, there are no results in war. A campaign proceeding without prisoners, without the capture of standards, cannon and equipage, is a state of hesitation injurious to the *morale* of our own army, and favourable to that of the enemy.

"Some officers suppose that the improvements of artillery and other rifled arms will render the action of cavalry more uncertain. These notions have been propagated in the army since the Italian campaign, in which the cavalry attached to the divisions in each *corps d'armée* was not led to play its true part in war. The fact is that the infantry was used, very brave and active as it was, too extensively in reconnoitring—an excess of such action, which, had the war continued, might perhaps have been disastrous; but its operations in this respect were necessarily too confined: had the cavalry been used to extend its reconnaissances to a distance, our army would have been better apprised of the movements of the enemy.

"It is also supposed that the greater range and accuracy of fire-arms renders the action of cavalry powerless. This notion may be well-founded if the cavalry is led by officers ignorant of its uses, or who are imprudent enough to charge a battalion in square, solid and in a good position. But if, instead of beginning with a charge, we first try the metal of this infantry by discharges of musketry or grape, to weaken its *morale*, and put a little confusion in its ranks, and after that trial charge vigorously and repeatedly, the uncertainty of the enemy's fire caused by their hesitation, and the surprise of the charge, will insure the success of cavalry; but to attack brave troops, untried, and within easy range, with cavalry, is a deplorable blunder, to be severely blamed, not only on account of its failure, but also its bad effect on the remainder of the campaign."

needed to support or reinforce promptly the threatened points, and to arrest the efforts and attempts of the enemy.

"20. *The Organization of modern Armies.*—For some time hitherto modern armies have been formed into *corps d'armée*, composed of several divisions, and a troop of cavalry, whose strength has not been precisely defined. Certain bases, calculated in accordance with the nature of the ground and the proposed intention of attack or defence, will not perhaps be useless to fix the proportions of cavalry, and the rules to follow.

"We must not too easily yield to the desire of the commandants of *corps d'armée* by according them more squadrons than the nature of the ground and the necessities of the war or the service require. Thus, in an open country, where the action of the cavalry may be useful to gain intelligence, to reconnoitre, to hold in check, or act on the offensive, one division of cavalry, composed of three regiments, cuirassiers or dragoons, and one regiment of light troops for the service of the staffs, will be sufficient. In a broken, woody country, the number of squadrons of heavy cavalry would be less than that of the light troops, which might furnish one regiment for the interior posts and escort-detachments, and another for exterior service, to act as scouts, and in diversion to gather intelligence for the army. In order not to fatigue them, these bodies might be relieved at fixed periods according to the orders of the commander-in-chief of the cavalry, who would reserve all power in the interest of the arm, acting, however, in concert and previous understanding with the major-general of the army.

"21. *Cavalry-reserve.*—The army being thus organised, it must have a reserve sufficiently respectable to reinforce the divisional squadrons, and protect the outposts of important detachments, without drawing them from the other corps, to be able to attack instantly the exposed points of the enemy. It is better to reinforce the weak points by squadrons from the reserve, than to form a reserve with squadrons taken from all the divisions. It is therefore of absolute importance to have a strongly constituted cavalry reserve, which may be flung out, at the opportune moment, to decide the great event of the day. However, the tactical management and handling of these masses can only be acquired by practice; the leaders must be used to it; they will play their part badly if they assume it unprepared.*

* In war the three arms must lend each other mutual assistance, but the cavalry and horse artillery are especially two "fraternal" arms, two inseparable companions. With reciprocal reliance in their training and valour, they will never fear to attempt these bold strokes that sometimes decide the success of a battle. They will perform together those rapid marches, bold and unexpected deployments, during which the artillery—skilfully unmasked—scatters disorder and confusion in the enemy's columns with its showers of grape, to be turned into complete rout by a sudden charge of the cavalry. But to this end there must be between all the arms the most perfect and mutual reliance and esteem, the true bond of which is the perfect knowledge by all of the principal elements of tactics, and the mode of action peculiar to each respectively.

It is certain that in future warfare the means of destruction, in defence, will attain such a development that it will be impossible to meet the difficulty according to the rules and principles of military art in its present state. Battle tactics, the organization of armies, the proportion between the three arms, in fact everything relating to the art of war, will undergo important modifications.

One salient result of modern tactics emphatically suggests the difficulty of the situation: the field of battle will be immensely more extended at its commencement; the troops posted by their officers according to the new system, will be for the most part lost sight of by the general-in-chief. Hence the increased labour, solicitude, and anxiety of colonels of

"22. *On the offensive return of Cavalry.*—The infantry and the cavalry owe a mutual co-operation to each other. An offensive return of the cavalry in a retreat may change the aspect of affairs completely. What happened at Maddeline is a proof of what the cavalry can do when led with prudence and hardihood. Marshal Victor was retreating before the Spaniards, covered by his squadrons. The enemy's general having committed the fault of pursuing him too near with his infantry, in the hope of driving him on the Guadiana, General Latour-Maubourg suddenly fronted and rushed like a thunderbolt on the Spaniards, who were not more distant than the range of a pistol. He dashed at their front with three regiments of dragoons, whilst Generals Lassale and Bordesoule hurled on the flanks of the enemy the 10th and 3rd Chasseurs. In less than five minutes the Spanish army presented only a confused mass, flying in all directions towards San Benito and Villa Neuva; 6,000 prisoners and 40 guns were the trophies of that affair. The Spaniards had cavalry, but it was not engaged; that arm, badly organised and loosely handled, behaved at Maddeline as it did at Ocana.

"Kellermann, at the battle of Alba-de-Tormès, at the head of six regiments of dragoons, surprised General Del Parque, who was retreating precipitately; he threw Del Parque's cavalry upon his infantry and routed him completely. The Spaniards lost 4,000 prisoners and 20 guns.

"Successful returns on the offensive raise the *morale* of the army and often spread discouragement amongst the enemy. It is therefore important that the infantry, that arm of strength and resistance, should be supported in its offensive movements and sustained in its retreat. The campaign of 1814 shows us what a solid and daring cavalry can do.

"The pursuit of General Olsouvief, made prisoner, with his staff, by Generals Girard and Doumerck, was an affair which left in our hands 300 prisoners and 30 guns. Nansouty and Letort, at Château Thierry, rushed on the Prussian and Russian battalions, pierced them, and brought back numerous prisoners and guns.

"The superiority of the French cavalry under the Empire resulted from the happy use of masses. The cavalry of the Allies was inferior to it, especially by reason of the system of dispersion imposed upon it and the neglect of the lessons of Frederick II.

"On the first of January, 1814, the French army numbered 71,012 men, 48,682 infantry, 15,478 cavalry, 6,852 artillery. The cavalry was therefore the fourth of the effective of the infantry, and we owe the prodigious spoil won at that epoch to its strength and very superior quality."

battalions and captains of companies in the employment of their troops, and following out the scheme of the battle as preconcerted. The generals of armies will scarcely have more to do than superintend the general dispositions of the plan, and take means to obviate accidents. After having laid down his plan of battle, the general-in-chief will become a simple spectator and observer; all he can do is to be ready to interpose at the proper time, and in the proper place. It can scarcely be expected from him, at the present day, to take advantage of any faults committed by his antagonist, as of old. The chief work will be done, if done at all, by his subordinates of all degrees, who will now be required to be masters of their art, full of depth and penetration, and, above all, endowed with the faculty of being always able to appreciate the march of events on a field of battle.

THE immediate result of this Report and its consequent deliberations was a small but most comprehensive book of instruction, carrying out the salient suggestion, namely, the *individual training* of the horseman, the rider and his horse. It is entitled *Instruction Provisoire sur le Travail Individuel dans la Cavalerie*—"Provisional Instruction for the Individual Training of the Cavalry." It lays down the object of the training as follows:—

"What constitutes the true horseman for the purposes of war is, besides his skill in the use of his arms, his dexterity in managing his horse at all its rates and on all sorts of ground, and consequently obtaining from the horse instant obedience in all movements that may be reasonably required; hence the necessity for practising the horseman and the horse in such conditions that both may be able to meet all the exigencies of war-service.

"This individual training will therefore have for its chief object the improvement of the rider in the management of his horse, to habituate the horses to separate from each other, and instantly to obey the will of the rider.

"The dispositions of this instruction are not applicable to the mere recruit, who at the commencement of his training finds already so much difficulty in understanding and performing all that he is taught; but one lesson at least a-week, in addition to the habitual exercises, must be devoted to gymnastics, military leaping, and the various exercises adapted to ensure the suppling of the body.

"The facility, the correct performance of the whole system, depends entirely on the long practice of the individual training; without it the tactical power of the cavalry remains stagnant and inert in the hands of its leader; with it that power may be infinitely developed. Therefore in this instruction the horseman is led progressively through a variety of movements more and more daring, and the training, by its very difficulty, develops the energy of the men, rouses their warlike instincts, and gives the army skilful, solid, adventurous—in one word—good horsemen for the purposes of war.

"By mastering the true principles of the training and presenting them in a proper order to the intelligence of the men, there is nothing that constitutes a warrior which may not be taught them. The officer-instructors will therefore find in the improvement of this individual training a constant stimulus to their special studies, and have the satisfaction of giving to our regiments horsemen worthy of the name."

This little book, full of work however, with its twenty-six beautiful plates, is well worthy of our consideration with a view to its adoption and application to our cavalry. The movements, especially the new ones, are all calculated to ensure the efforts of the cavalier by their beautiful design, imposing advances, splendid wheels in every possible variety, a grand affair emphatically termed the Carrousel, and a powerful column movement perfectly resembling and called the Cross of Malta.*

* It should be stated that the French assiduously practise their cavalry to manœuvre in the inverted order. The cases are frequent in war where the natural order of formation would be either most dangerous, or attended with the loss of precious time. For instance, in the passage of a defile forward, the cavalry may have to form line by a processional movement on one side as well as the other: it must therefore be accustomed to manœuvre in the inverted order, so as not to hesitate on such an important occasion, in which success depends upon rapidity of execution. Manœuvres in the inverted order,

By endowing the cavalry with mobility and rapidity, and placing it in the hands of a competent commander, it becomes indeed a formidable arm, of the utmost importance in the field of battle. In the twinkling of an eye, cavalry has frequently changed a desperate conflict into glorious victory. Strokes of power, strokes of audacity, strokes of genius, are the special and peculiar exploits of cavalry, says Guibert; and General Marbot reminds us that it is often at the very moment in battle when all seems lost, that a brave cavalry finds its best opportunity for winning distinction, by boldly rushing upon the enemy at a moment when he can be easily conquered, precisely for the reason that he already thinks himself victorious. Thus, at Marengo, 500 horemen, led by Kellermann, pouring down furiously on the Austrians at the moment of their greatest success, utterly stunned them by the vigour of the attack, pierced them on several points, and contributed by this brilliant charge to snatch from them a victory of which they had believed themselves assured.

Such, then, are the views and considerations which have directed the recent improvements in the French cavalry, whose results have been most satisfactorily demonstrated at the camp of Châlons.

Colonel the Baron d'Azemar completely expresses the opinion of the generals of his country in the following averment: "Were it permitted to raise for a moment the veil that hides the future of the cavalry, we are persuaded that we shall see its destinies enlarged. Yes, that is our conviction. Henceforth the only part that the cavalry will play in the field of battle will be to strike decisive blows, to fulminate, to annihilate the enemy. In battle, cavalry will appear like lightning; its action will be as terrible as it will be unforeseen and unexpected; it will warrant more than ever that ancient and poetical qualification of the Bible—a horse-storm: *procella equestris*."

The French have got the start of us—as in everything else—in their cavalry improvements. It remains to be seen whether we shall "take action" in this most imperative want and preparation, without waiting for the stern and cruel lesson of our habitual and proverbial teacher—DISASTER.

which we should avoid as much as possible in the infantry, must be familiar to the cavalry, which has frequently to form with the rapidity of lightning on the flanks and forward, whether it be right or left in front. It would lose all its advantages if the inconveniences of the inverted order could fetter its movements. If, for instance, on debouching from the defile it had only room to deploy on the right of the infantry, it should—in order to form as rapidly as possible—execute the manœuvre by inversion on the left into line, supposing it came up right in front; but, if it be not accustomed to this movement, it would be dangerous to perform it for the first time under fire. Consequently the commander would have to continue his march until his whole column is unmasked and form to the left in line; and, if he has a battery or the enemy's cavalry on his flank, it is probable that he will not execute the manœuvre without disorder: at all events he will have lost time, which is always disastrous. It is, therefore, very essential that the cavalry should be practised in forming line in the inverted as well as in the natural order. Many troops have received notable checks by not being able to fight in the inverted order; the Seven Years' War gives several examples.* Decidedly our infantry should be practised in these inversions, as they may be needed. The new French battalion drill insists upon their importance. See "Ecole de Bataillon," pp. 117 and 84.

* General Dufour, *ubi suprà*.

Evening Meetings.

Monday, May 20th, 1861.

Colonel P. J. YORKE, F.R.S. in the Chair.

ON A MODEL ILLUSTRATING THE PARABOLIC THEORY OF PROJECTION FOR RANGES IN VACUO.

By Lieut.-Col. A. LANE FOX, Gren. Gds.

The idea of illustrating the parabolic theory by means of a model occurred to me in 1853, when the School of Musketry was established at Hythe. It was part of my business as chief instructor to give lectures to the non-commissioned officers and men sent there for instruction upon the theory of projectiles, with a view of rendering them familiar with the use of their sights at all distances. It was, of course, desirable that such lectures should be as simple as possible, and the object of the model was to enable them to take in the subject quickly by the eye, without perplexing them with mathematical terms and problems, to which they were unaccustomed.

The parabolic curve, as all those acquainted with the principles of gunnery are aware, differs materially from the true curve described by a projectile in the air. But in explaining the principles of gunnery, the parabolic theory is a necessary preliminary to be gone through, for the true curve is simply a modification of the parabolic curve caused by the presence of another force, viz., the resistance of the air, which is not included in the parabolic theory.

It is, I fear, somewhat a threadbare subject; but, at the risk of appearing tedious, I will briefly remind you of the history of these theories.

For some time during the use of the early cannon which were employed only to blow open barriers, or against troops at a very short range, it was supposed that the bullet flew for some distance in a straight line, and then dropped suddenly, and it is not improbable that the large rings at the muzzles of the early cannon may partly have originated with a view of rendering the line of sight parallel to the axis of the piece, and thereby of enabling the gunners to aim, as they supposed, more accurately at the mark to be hit.

In 1537, Tartaglia, an Italian mathematician, was the first to point out that no part of the track described by a bullet was in a straight line, but he considered that the curvature was in some cases so small that it need not be attended to, comparing it to the surface of the sea, which, "though

undoubtedly incurvated round the centre of the earth, may nevertheless be regarded as a plane when partially considered."

In 1638, Galileo determined that the flight of a shot would be in the curve of a parabola, unless it was turned from this track by the resistance of the air. For upwards of a century after this discovery, parabolic theory was, I believe, regarded as sufficiently near the truth for practical purposes. It remained for Robins, in 1742, to show that the effect of the atmosphere was considerably greater than before was supposed; and he proved by actual experiment that a 24-pounder did not range a fifth part of the distance which it should do according to the parabolic theory.

In describing the three forces which combine to influence the flight of a projectile in the air, we may therefore take them in the order of their discovery: 1st. The velocity caused by the exploded gunpowder, producing a movement of transition in continuation of the axis of the piece. 2ndly. The force of gravitation drawing the bullet to the ground; and 3rdly. The resistance of the air.

The parabolic theory deals only with the first two forces, viz.: the movement of transition and the movement of gravitation. So far all is accuracy and precision; but in approaching the question of the resistance of the air, we begin to tread upon what is still disputed ground. It is so uncertain in its effects, that it cannot, I believe, be accounted for with any degree of accuracy. It not only varies continually in its own resisting property, but it varies with the velocity, form, and density of the projectile, and when the velocity exceeds 1,300 or 1,400 feet in a second, there is then a vacuum in the rear of the ball which adds to the difficulty of calculation. Besides which the elongated projectiles now in use, having a tendency to continue with their long sides parallel to the axis of the piece during the whole course of their trajectory, never present the same surface to the atmosphere in any two moments of their flight; all which renders the calculation one of the greatest difficulty, if not impossible: and, although I believe there are officers still engaged in trying to discover the true principles who do not despair of arriving at some degree of precision, in calculating the range at least of spherical shot, it may, I believe, be said without fear of contradiction, that no calculation has yet been made with sufficient accuracy to render the attempt worth making for the elongated projectiles now in use in the service. I therefore prefer to leave that part of the subject in the hands of those better qualified than myself to deal in so abstruse and difficult a problem, and to confine myself on the present occasion to showing how the action of the two forces concerned in the parabolic theory may be brought home to the perfect comprehension of non-commissioned officers and men not previously instructed in any branch of mathematical knowledge, by means of the model now before you.

A B represents the cannon to be fired, which is attached to a moveable bar B C; the whole is constructed to turn upon a pivot at the muzzle of the gun B; an index is fixed at the other end of the bar C, by which it may be set to any angle of elevation or depression, by passing it along the circumference of the circle C D E F G H K, on which a scale of 135° is protracted: the moveable bar B C represents the "line of fire" and the direction of the movement of transition. In this direction (according to the first law of motion, by which a body once set in motion pre-

serves the same direction and velocity originally imparted to it, until some other force interferes to check its velocity or turn its course,) the bullet would continue to move uniformly for ever, with the same velocity originally imparted to it by the explosion of the gunpowder, traversing equal spaces in equal periods of time, were it not for the force of gravitation drawing it towards the ground. This moveable bar or line of fire is divided into thirty equal parts, representing the points at which the bullet, if influenced by the force of transition only, would arrive at the end of each successive second of time. In the present instance it is supposed to move at the small velocity of 321·6 feet or 107 yards per second.

B L is a fixed line representing the direction of the force of gravitation: in this direction the bullet would fall, if dropped from the muzzle without receiving any movement of transition. Now the movement of gravitation, according to the recognised law of gravity, increases as the square of the times, *i. e.* supposing the bullet to fall over a space B M during the first 10 seconds, it will accomplish four such spaces B N during the first 20 seconds, and at the end of 30 seconds it would have reached L = 9 times B M.

Having now described the two forces separately, viz. the force of transition and the force of gravitation: the instructor may proceed to show that, according to the second law of motion, by which a body impelled by two forces in different directions describes a diagonal to the lines representing those two forces, the bullet, influenced by both transition and gravitation simultaneously, the one being uniform whilst the other is an increasing motion, is constrained to move in the curved parabola O P R. To ascertain the position of the bullet at any given moment of time, as for instance 10, 20, or 30 seconds, and at any angle of elevation or depression, it is only necessary to mark off upon the "line of fire" the spaces B S, B T, B U, due to the movement of transition, and on the line B L the spaces B M, B N, B L, due to the fall of gravitation; draw the parallel lines (M O—S O)—(N P—T P)—(L R—U R), and the intersections O P R will indicate the points at which, according to the parabolic theory, the bullet will arrive at the end of 10, 20, and 30 seconds respectively. From each of the 30 points on the moveable bar, a wire is suspended with a white bead at the end; these wires increase in length, as the squares of the times, according to the fall of gravitation, at each successive second of time: thus the first wire 16·08 feet in length represents the fall in 1 second; the length of the tenth or any other wire is obtained thus $10 \times 10 = 100 \times 16{\cdot}08 = 1608{\cdot}$ feet, or the fall of gravitation in 10 seconds; the length of the twentieth wire is 6,432 feet, and so on. By this means a uniform curve is produced throughout the parabola, each bead representing one second of the actual flight *in vacuo*.

The parallelogram apparatus M N L O P R is moveable on pivots at L and M, by which means it may be adjusted to any angle at which the index C of the moveable bar may be set; the points O P R of the parallelogram apparatus always coinciding with the beads indicating the tenth, twentieth, and thirtieth second of time, thereby demonstrating at all angles of elevation or depression the operation of a compound force.

The range on any plane, and at any angle of elevation, may be shown by setting the moveable bar with its suspended wires to the angle indicated,

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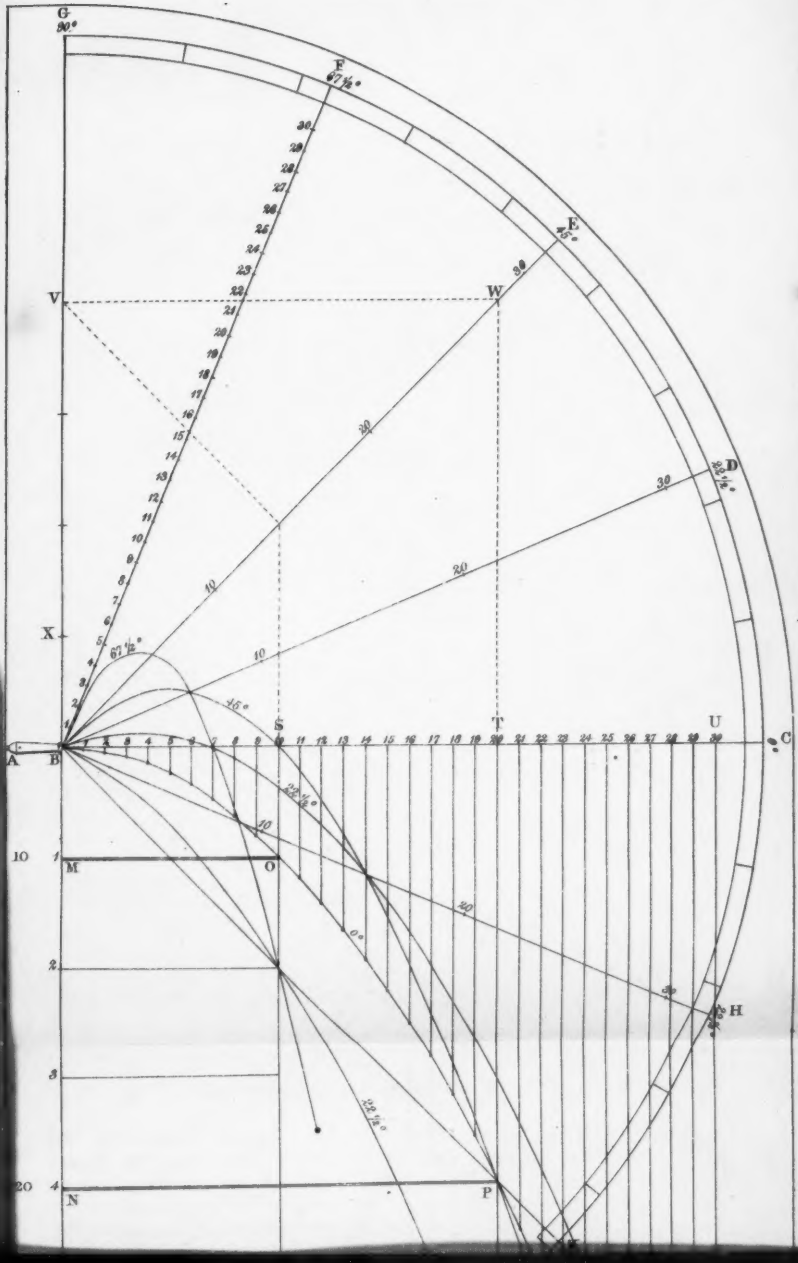
The range on any plane, and at any angle of elevation, may be shown by setting the moveable bar with its suspended wires to the angle indicated,

and marking the intersection of the line of beads upon the plane drawn with a white line upon the board; the number of beads above the plane denoting the time of flight. For instance, if the index is set to 22½° elevation, the intersection of the beads with the horizontal plane will be at 760 yards, the time of flight 8 seconds. At 45° it will register 1,068 yards and 14½ seconds; at 67½° the range will be again reduced to 760 yards, but the time of flight will be increased to 18½ seconds. It is, therefore, shown that the greatest range upon a level plane is at an angle of 45° elevation. In this case the angle of descent will be seen to equal the angle of ascent; the vertex or highest point of the trajectory will be situated in the centre of the range, and its greatest height will be equal to one-fourth the range, or to one-half the *impetus* or height to which the ball would ascend if fired vertically; consequently the impetus is equal to one-half the range when fired at an angle of 45°.

Upon every plane, whether of elevation or depression, the greatest range is at an angle equal to half the angle formed by that plane and the perpendicular: thus, on the level it is 45°; and on a plane depressed 45° below the horizon, the greatest range is at 22½° elevation, or an angle of 67½° with the plane. It may also be shown, that on every plane there are two angles which register the same range; the two together equalling the total angle formed by the plane and the perpendicular. Thus, on the level plane; 22½° and 67½° give the same range: and on a plane depressed 45° below the horizon; 67½° elevation gives the same range as 22½° depression: also, upon the same plane; 45° of elevation gives the same range as a shot fired at 0°, or the level. If the index is set to 67½° elevation, or an angle of 22½° with the perpendicular; it will be found that the curve thus produced will cut any given plane at the same spot as if set to 22½° *with that plane;* showing that with a given angle of elevation the range increases in proportion as the plane departs from the zenith and approaches the nadir.

All the problems connected with the parabolic theory may, I believe, be shown on the model, but there is an arrangement specially adapted for showing how the range on any plane may be obtained from the *impetus*. The impetus B X, as I before said, is the height to which the ball would ascend if fired vertically. From the point B on the perpendicular B G set off a space B V equal to four times the impetus; then to obtain the range upon any plane at any angle of elevation, mark off from the point V, with the line V B, an angle equal to the elevation, produce the line till it touches the "line of fire," let fall a vertical line upon the plane, and the intersection will be the range upon that plane. For instance, to obtain the range upon a plane B K depressed 45° below the horizon at an elevation of 90° with the plane, B E will be the "line of fire" from the point V: set off V W at an angle of 90°, and from W let fall a vertical line to P, then B P will be the range on the plane B K, at an elevation of 90° with the plane. The lines V W — W P are shown on the model by a thread with a weight suspended. A protractor is fixed at V, and a moveable arm is used to hold the thread at W or any other point upon the surface of the board.

It only remains to be said that, although the parabolic curve gives no approximation to the range of shot fired in the air with great velocities,


G
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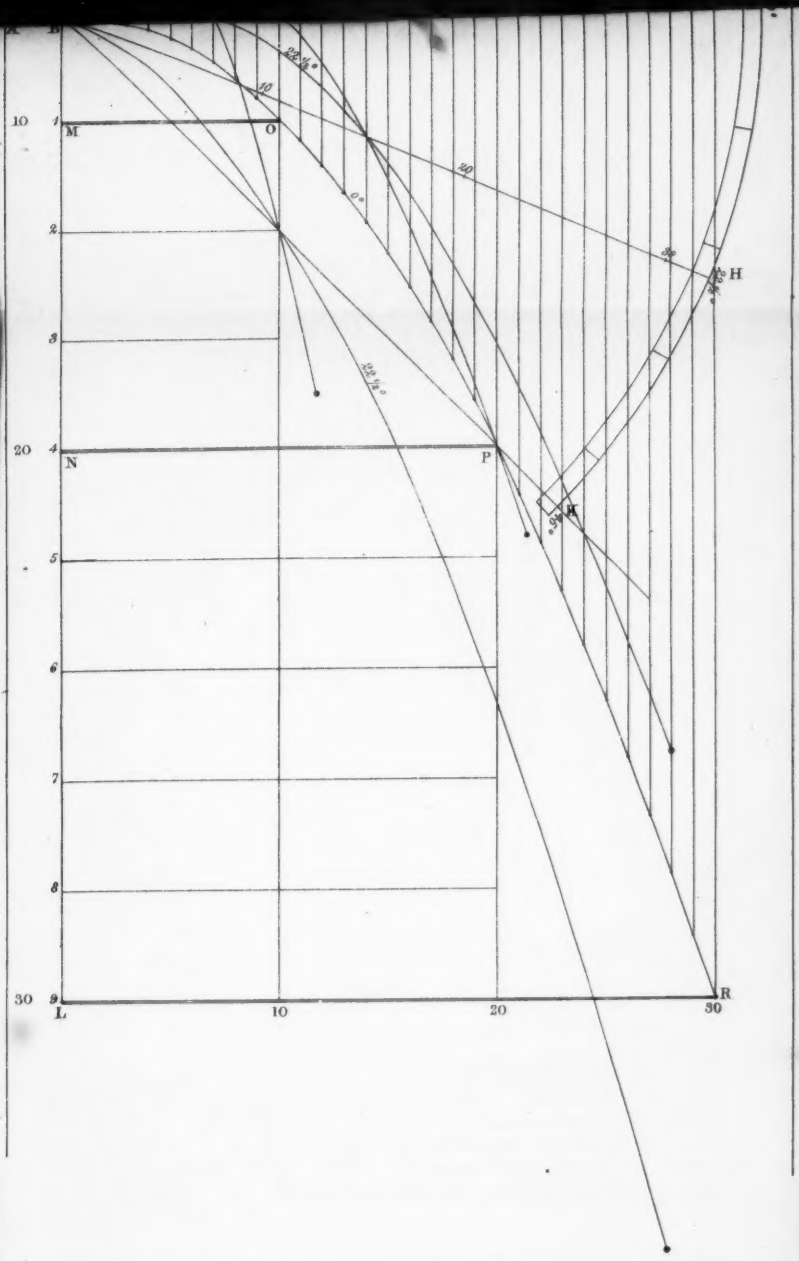


PARABOLIC THEORY OF PROJECTION

FOR RANGE IN VACUO.

A. Lane Fox, Lt. Col. Gren. Guards, Invent.

J.R. Jobbins

yet Sir Howard Douglas informs us in his "Naval Gunnery" when the velocity does not exceed 200 or 300 feet in a second the resistance of the air is very small. In the present instance, the velocity assumed is 321·6 feet per second, and we may therefore presume that with a heavy projectile the curves here shown do not depart materially from the truth.

From the above description it will be seen that the model has no claim to novelty in regard to the principles on which it is constructed, being simply an illustration of the laws of motion discovered by Galileo two centuries ago. These laws, as I before said, are of little practical value to the artillerist, for, though true so far as they go, they do not present the inquirer with the whole truth of a bullet's flight in the atmosphere, taking no account of that most influential element which has hitherto baffled the efforts of scientific calculators. As the parabolic theory must, however, continue to form the basis of all future efforts in this direction, it may not, I trust, be thought that I have altogether engaged myself or occupied your attention upon a work of supererogation, if the model in any way contributes to improve the roadway upon this already well-beaten path, or to facilitate the early stages of those who may undertake fresh researches in this particular branch of mathematics. I have made some slight additions to the model, which was originally designed for the school of musketry, and in its improved form it may perhaps be found useful to those numerous officers and others who are now engaged in the instruction of gunnery and musketry.*

THE CHAIRMAN: We are very much obliged to Colonel Fox for bringing forward this very beautiful and ingenious model, and also for the short summary he has given us of the subject. It seems to me an exceedingly beautiful illustration, an elegant method of showing what the parabolic theory is. I hope some gentlemen who are conversant with the subject will favour us with some remarks.

Major-General ANSTRUTHER, C.B.: I do not think anybody could find fault with this explanation of the parabolic theory. Colonel Fox's explanation has absolutely thrown light upon it to me, who have been thirty and more years studying the subject. It shows how beautifully simple it would be, if we could but get over the resistance of the atmosphere. There is no doubt, that that is the perfectly true theory, if the resistance of the atmosphere did not act.

* I wish to add, that in carrying out the practical details of construction I received much valuable assistance from Mr. Becker, of Messrs. Elliott Brothers in the Strand, whose great mechanical ingenuity has already been brought under the notice of this Institution on a previous occasion.—A. L. F.

Monday, June 17th, 1861.

Captain M. S. NOLLOTH, R.N. in the Chair.

NAMES of MEMBERS who joined the INSTITUTION between 10th and 17th June, 1861.

LIFE.

Warry, E. T., Lieut. Royal Artillery. 9*l.*

ANNUAL.

Hall, H. E., Capt. 13th P. A. Lt. Inf. 1*l.*
Robinson, Sir Hercules, Governor of Hong Kong. 1*l.*
Schreiber, F. W., Lt.-Col. 2nd Batt. Suffolk Rifle Volrs. 1*l.*

SAILS OF STEAM VESSELS.

By H. D. CUNNINGHAM, Esq., R.N.

THE earliest steam-vessels appear to have been fitted with sails. It is probable that much distrust in the stability of the new propelling power suggested the necessity of retaining the sails to fall back upon, in the event of failure of the steam-power. As the early steam navigators became more venturesome in their voyages, and it was found that steam-vessels were capable of doing more than canal or river work, it would also be discovered that sails were useful for steadying the vessel in a sea, and in more lengthened voyages the economy of coal must have been an early care, and the use of sails resorted to for that object. It would appear that attempts were made to turn the funnel to more account than merely a chimney, for we find it used in some of the primitive steam-boats as a mast. The fore-and-aft mode of applying sails early suggested itself, as the more suitable for vessels which were intended to be propelled against the wind. One of the first Government steam-vessels, I think the "African," was rigged with lateen sails. The lowering of the mast was also considered a requirement, and there were many inventions for accomplishing this. As the voyages of steam-ships increased in duration, the necessity for increased sail-power was suggested, and also of employing square sails for using off or before the wind. And in the year 1828, I recollect seeing H. M. ship "Confiance," at Chatham, rigged as a square-topsail schooner. A great imagined difficulty with early steam-ships was the fear of the sails catching fire; and even the rigging was a source of much anxiety, and catastrophes of this kind were ever being predicted by old hands, who viewed the mighty innovator that was to change the whole aspect of nautical affairs, with no small contempt and dislike. The rig of the "Confiance" has been continued amongst a

certain class of steamers to the present day. The steam-ships of the Cunard Line, the Royal Mail Company, and, until lately, the Peninsular and Oriental Company have been rigged as square-topsail schooners; viz., fore-and-aft sails on the after-masts and square sails forward. These ships have often to be driven for days, even for weeks, against strong head-winds. In this position, of course, the yards cannot fail to be a great detriment, offering very great resistance to the progress of the ship, and means are adopted to lessen this evil as much as possible. In most of these ships, therefore, the foreyard works up and down on a kind of trysail-mast, on the foreside of the mast; this admits of the foreyard being easily lowered down when steaming head to wind. In some instances a chain jackstay is used instead of the trysail-mast. It is also sometimes necessary to get the topsail-yards down, an operation of course attended with much inconvenience and difficulty at sea, with a small crew of seamen. The Peninsular and Oriental Company have lately abandoned the standing square sails in some of their steam-ships, and adopted a fore-and-aft rig, similar to the Royal yachts "Victoria and Albert," "Osborne," &c., with arrangements for setting a square foresail and, I believe, topsail flying.

So long as the early Government steamers were employed merely for service in the English Channel, the sails were not viewed of so much importance; but when they assumed the character of war-ships, and their services were required in distant Foreign stations, the necessity for increasing their sailing powers was apparent, not only to economise coal, but also on the score of expense, as the cost of coal was then beginning to open the eyes of the Admiralty to the costly nature of the new order of things which steam was evidently bringing about. With stringent orders to commanding officers regarding economising coal, by using sails as much as possible, and with some beautiful valvular arrangements for using steam expansively, came about greater fulness in the rig of the war steamers, until their masts and yards assumed the proportions of ordinary sailing ships.

I have hitherto thus briefly traced the history of the use of sails on board steam-vessels, and the various arrangements for applying them with reference to paddle-wheel steamers. But, in the year 1834, as is well known, a new mode of propelling ships by steam was proved to be practicable, when Mr. Smith and his little experimental steamer "Archimedes" lifted the mechanical veil which hid behind it a view fraught with the deepest interest, not only to navigation, but to the destinies of nations. With the success of the "Archimedes," the steam-ship assumed a different character. Shorn of her unsightly and cumbrous paddle-boxes, the ship was, as it were, re-born in all her pristine beauty; recommending herself to the loving eye of the seaman to be again dealt with more in the fashion of a sailing-ship.

It will be well known to my naval readers that the first screw steam ship-of-war was the "Rattler." This vessel was rigged as a barque, or rather two-topsail schooner; indeed her rig was precisely similar to our present despatch boats. Soon after the "Rattler," the "Great Britain" made her appearance. She had four masts, two of which were furnished with square sails. After this the production of screw steam ships, both for

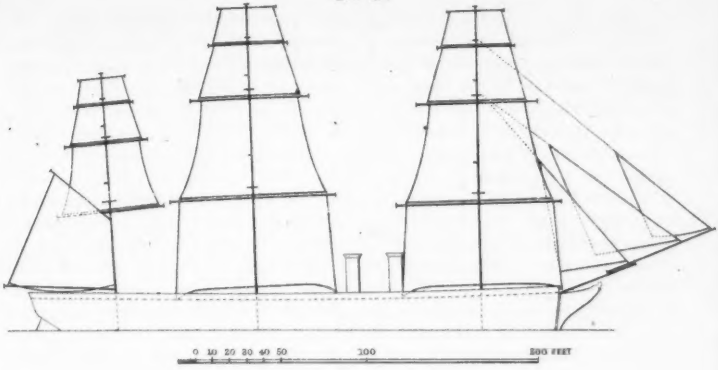
the mercantile marine and royal navy, progressed rapidly, until the efficiency of this new mode of steam propulsion became an established fact. For many years, however, after it had been proved that ships could be propelled by the screw, the most appropriate arrangements for applying the sail-power remained a question. It was found that the navigation of a screw-steamer differed in some respects from a paddle-wheel vessel; that, whereas the latter vessel could be driven with advantage against the wind, it was better, if possible, with the screw-vessel to keep sail on her as near as she could lie to the wind, which, with fore-and-aft sails and the power of the screw, could be accomplished most effectively; and thus to work her as it were to windward, in which position of course yards would be a great detriment. This consideration, therefore, pointed out fore-and-aft sails even to be more suitable to the screw-steamer than the paddle. On the other hand, much of the advantage of the screw steam-vessel was anticipated by her superior adaptation for sailing. With no paddle-wheels to drag in the water and thus retard her way, she was expected to possess all the capabilities of a sailing ship; and by the use and superior power of square sails, especially, she would be able to dispense, to a great extent, with the use of the steam-power, and thus economise fuel, and be rendered more efficient for long voyages. The question of the rig of screw-steamers also depended on the consideration whether the steam-power was to be applied in an auxiliary form or assume the character of a principal; in the former case, the ship would require more fulness of rig, as the steam-power would only be employed in calm or light winds, or in going in or out of port, when at other times the ship would depend on the sail-power alone. In the latter case the sail-power might be viewed as the auxiliary, and a lighter description of rig admitted.

Practical experience has, however, set this question at rest by the adoption on board of all ocean-going screw-ships of a rig approaching as nearly as possible in character to that of an ordinary sailing ship, varying only in fulness in proportion to the extent of the steam-power; high-powered steam-vessels requiring lighter sail-power than when the steam exists in an auxiliary form. In all cases, too, it is endeavoured to provide as extensive a system of fore-and-aft sails as possible, in addition to the square sails; thus, all ocean-going steam-vessels are furnished with capacious trysails, staysails, &c.

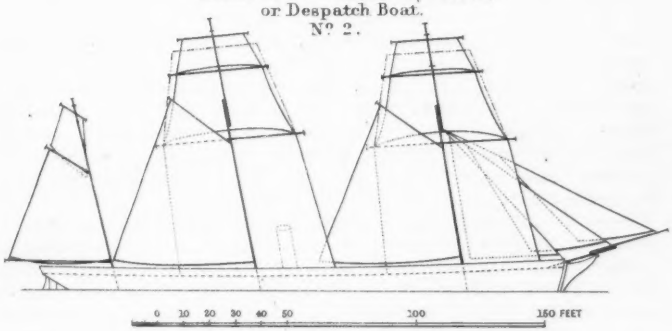
In Figs. 1, 2, and 3, Plate 1, are shown the sail arrangements in three descriptions of ships belonging to the royal navy,—a frigate of the Mersey class, a despatch-boat, and a gun-boat.

Although the rig of the ordinary sailing ship has been thus adopted generally in ocean-going screw-ships, there have been instances where this has been departed from. We have before alluded to the "Great Britain" having four masts, and this plurality of masts has been adopted in other cases. One of the fine screw-transports actively employed in the Crimean war, I think her name was the "Adelaide," had four masts; the sails on the foremast were of a fore-and-aft kind, those on the two middle-masts square, and those on the mizen-mast again fore-and-aft. I have seen some coasting steamers too with four masts. The "Great Eastern" has, as it is well known, six masts. In the first instance the sails on the foremast were fore-and-aft, on the next two masts square sails, and the remainder fore-and-

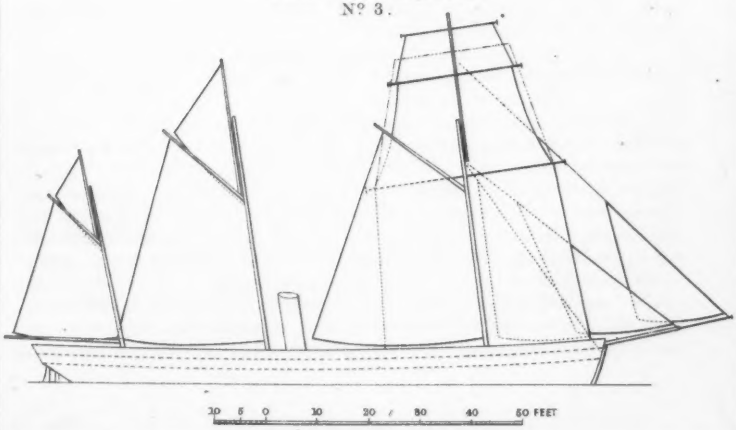
Sails of Frigate (Mersey Class)
N° 1.



Sails of 1st Class Gun Vessel,
or Despatch Boat.
N° 2.



Sails of Gun Boats.
N° 3.

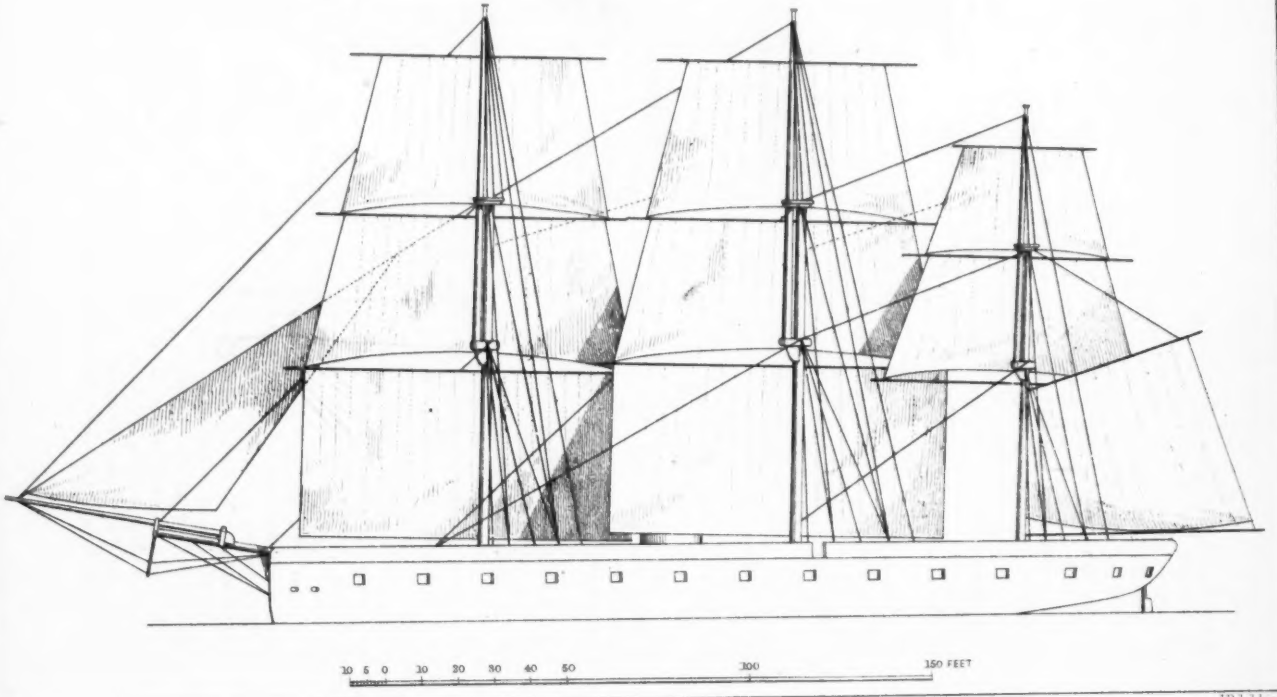


aft. I can scarcely quote the Great Eastern as a screw-ship, as she is more of a hybrid character, with her paddle-wheels and screw together, although my impression is she will not long remain in that condition; I believe she will in the end be altogether a screw, or altogether a paddle. On her last voyage the square sails were removed, and she was entirely fore-and-aft. Some time ago the French attempted to introduce the polacca rig into their navy, and a screw line-of-battle-ship was rigged on that plan. The other day I was on board of the "Prince Jerome" steam-yacht at Havre, rigged as a polacca bark. It is, perhaps, doubtful if the French "La Gloire" can be considered an ocean-going steamer, but it may be well to quote her, as showing that some doubt still exists amongst French engineers as to the best rig of screw steam-ships, from the strikingly spare rig which they have given to this large frigate. In the Mechanics' Magazine of 3rd June, 1859, a new plan for rigging war steam-ships was proposed by Captain Schomberg, at present commanding H. M. ship "Cumberland." He proposed to apply a topsail-yard at the cap, on the American plan, and to roll up the topsail above, on my principle. He also proposed to apply my principle of reefing to the top-gallant sail, which was to be made of extra depth, so as to dispense with the royal. I was on board a Dutch corvette at Toulon, in December last, fitted on this plan, and the commander spoke very highly of it. The upper topsail sheets were stoppered to the lower topsail yard, and the sail, when rolled up, was really very snug. I may here observe that my principle of reefing from the deck is largely used on board screw-steamers. Several of the steam troop-ships of the navy are fitted on my principle; in many cases I have caused the topsail to be fitted to roll up beyond the close reef; the advantages to be gained in the application of my system to screw-steamers, is that sail can be so easily made and shortened. By fitting the topsails and topgallant-sails to roll up close to their feet, the square sails can be readily taken in from the deck in the event of the wind heading, and again easily set when they can draw. Thus advantage can be taken of every slant, however small, and the ship derive considerably more help from her sails than could be on the old plan. A considerable quantity of cordage, too, is saved aloft, a most desirable consideration in the rig of a screw-steamer. On board H. M. ship "Megæra," they have done away with the topsail bowlines; thus, with the abolition of reef-tackles and earings, many hundreds of fathoms of rope are dispensed with, and by rolling up the topsail altogether, a still further reduction may be effected in the clewlines and buntlines.

On the equipment of the steam flotilla for China, Lord John Hay was most anxious for the gun-boats, and even the despatch boats, to be fitted on my system for reefing, and a Committee was ordered to examine into his lordship's proposal. Although I have reason to know the report of the Committee was most favourable to the plan, it was not carried out. The design was for the gun-boats to have one large topsail, fitted on my system, to roll up to the foot, instead of a topsail and topgallant-sail on the old plan. The dotted lines shown in Fig. 2, Plate 1, were about the proportion of the sail proposed by Captain Gardner, one of the Committee. There can be no doubt but that this would have been a most excellent and judicious rig for these vessels, not only on account of the exposure saved to the

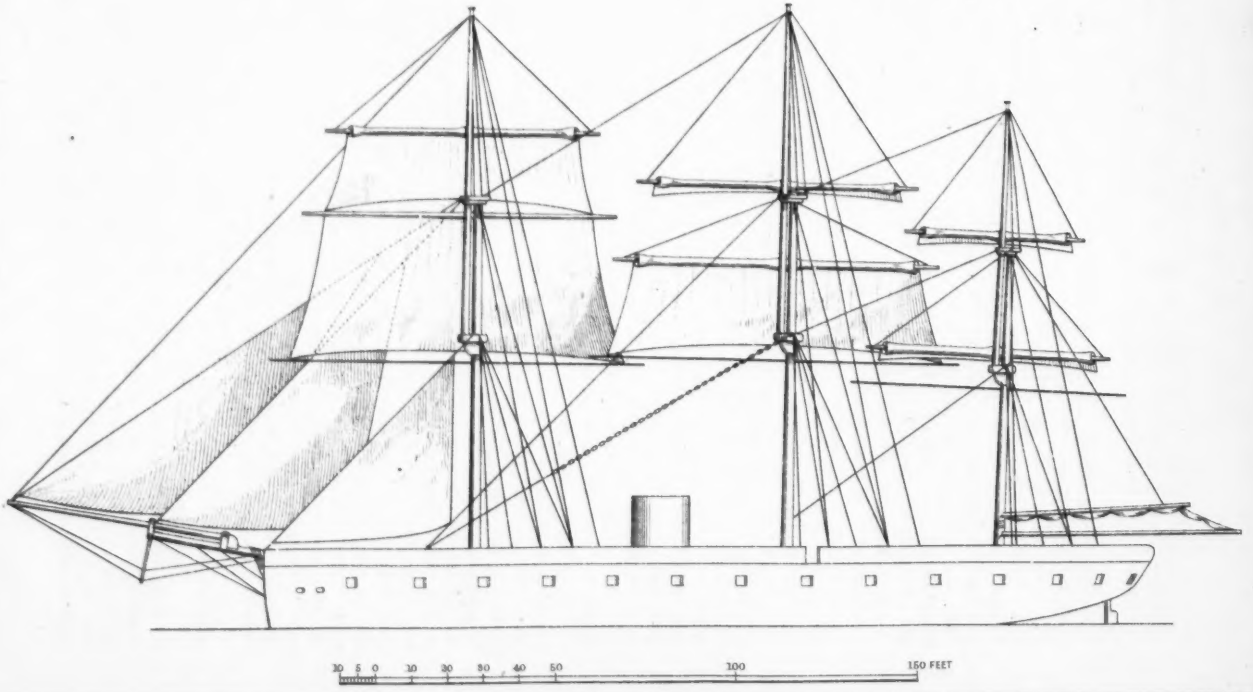
men in handling these sails, from the uneasy and dangerous motion which these vessels are subjected to, but the ability to make and shorten sail under fire of musketry, which a vessel of this kind may be exposed to, without sending men in the rigging, would be a valuable provision. I proposed to fit chain topsail sheets and ties, and as this would have been all the gear required for reefing, furling, making, and shortening sail, the gun-boat would have been scatheless against the effects of rifle-shot on the running rigging. In regard to the despatch-boats, I proposed a similar arrangement, increasing the topsails, as seen by the dotted outline in Fig. 3. Whilst cruising in my little brig last summer in Stokes Bay, I was nearly run down by a screw-frigate, and, as her stern came end on, after shaving me very closely, I was particularly struck with the extraordinary manner her spars were moving about with each pulsation of the screw; the topmasts and topgallant masts wagged from side to side really in a terrific manner, whilst everything aloft partook of this trepidation. On reflecting on this, it occurred to me that the old arrangement of spars was not suitable for a screw ship; that there were too many joints in the spars, and that the points of juncture were too close together; for example, when a slightly flexible stick is held upright in the grasp only of one hand, a wagging or swinging motion is easily imparted to the stick by a very small motion of the hand. This hand will represent the support of the topmast, as at present arranged at the cap and trussel-tree. But suppose another hand be applied to the stick at a distance from the other one, the part of the stick that remains above the upper hand will not be so easily affected by the motion of the hands. This might represent a topmast with the cap removed considerably higher up, which would certainly remain steadier under the convulsive throes of the ship than with the supports closer together. This led me to design the following arrangement for a screw ship-of-war. I propose, as will be seen by Plates 2 and 3, to elongate the lower masthead, and to have one simple topmast, the heel of which to be supported by a chock at the place of the former trussel-tree, the fore-part of the chock to be fitted with a clamp to release or confine the heel of the topmast. At the cap I propose cross-trees to stick out two shrouds, as I should trust for the principal support of my topmast to the backstays. Masthead shrouds will lead from the lower mastheads. On the heel of the topmast I propose to have a topsail, and upon the topmast above I propose to have another topsail. These two topsails to contain, or nearly so, the area and propelling power of the old topsail, top-gallant-sail, and royal; the latter of which I should dispense with. Both these topsails should be fitted to roll up on my principle. I would have the lower masts made of iron, and as much iron and chain admitted in the construction of the yards and rigging as possible. The trusses of lower yards should certainly be iron, as the yards can brace sharper up when so fitted. I would have step cleats on the lower mastheads for mounting to the cross trees. The dotted lines show that more capacious trysails can be applied with this arrangement. In Plate 3 the upper fore-topsail is shown half-reefed. On the mainmast the upper topsail is rolled up, and the lower topsail half-reefed: on the mizen-mast both the topsails are rolled up. The clues of the sails are not represented as hauled up, they are merely as they would be when the sail is rolled up to its greatest extent.

Mr CUNNINGHAM'S PROPOSED PLAN FOR RIGGING HEAVY STEAM SHIPS.



J.R.Jobbins.

Mr CUNNINGHAM'S PROPOSED PLAN FOR RIGGING HEAVY STEAM SHIPS.



J.R.Johhins

Of course all these topsails are reefed, and rolled up, and unrolled from the deck. My impression is that this arrangement admits of much reduction in the number of ropes and spars, and from its simplicity is well adapted for a large war screw-steamship.

But, after all, when we contemplate the maze of rigging and spars which constitute the rig of a first-class steam-ship, when we consider the huge yards extending their arms on either side, as if on purpose to resist the progress of the ship, and which cannot be effectually got rid of even when braced forward as far as they will go; when in a calm we see the ensign of a fast screw-ship blown out as if acted upon by a strong wind, and consider what inconceivable resistance must be opposed to the ship's progress when steaming against a strong breeze; when we consider, too, the immense weight aloft, the fly-wheel-like momentum which must be given to the ship in rolling by all this weight, I believe that the impression cannot fail to be received that the service of the sail-power, as thus obtained, is at a tremendous sacrifice of the power and capabilities of the ship as a steam-ship, and that the present arrangements for applying the sail-power are defective, and not consistent with the progressive improvements that have been made in the steam-ship otherwise.

After more than two years' very attentive study of this subject, together with some experiments, I have been led to believe that a rig by which a steam-ship shall have the character of a fore-and-aft rig in respect to removing the yards, and at the same time have at her command a powerful system of square sails for using off the wind, can be arranged, although, singularly enough, it must be with the almost entire reversing of all existing arrangements aloft. It is now some years ago since I remember hiding myself behind a crane in the docks, at Southampton, to avoid the jibes and sneers which were levelled at me whilst trying, for the first time, my invention for reefing from the deck; yet, preposterous as my views were then held by the practical world, I have been permitted to see that invention universally established as a practical fact. Bold, however, as the past may make me, I must confess it is with some hesitation that I come before a meeting of practical seamen to propose anything so strikingly novel as placing the square sails of a ship on the aft side of the masts instead of the fore, of putting the rigging forward instead of aft, and placing the stays aft instead of forward; of having the yards in two pieces instead of one solid piece, and of turning square sails into fore-and-aft sails. Yet, complete as this change of existing systems may be, it is only by such a thorough upset that I believe the desired point can be arrived at: viz., to provide a rig for screw steam-ships which shall afford the means of using square sails when off the wind, and fore-and-aft sails when on a wind, and this without yards or other impediments to the progress of a ship when steaming head to wind, at the same time with a reduction of weight aloft.

With the help of Plates 4 and 5, which are representations of a frigate of the "Mersey" class, I will now endeavour to explain the design.

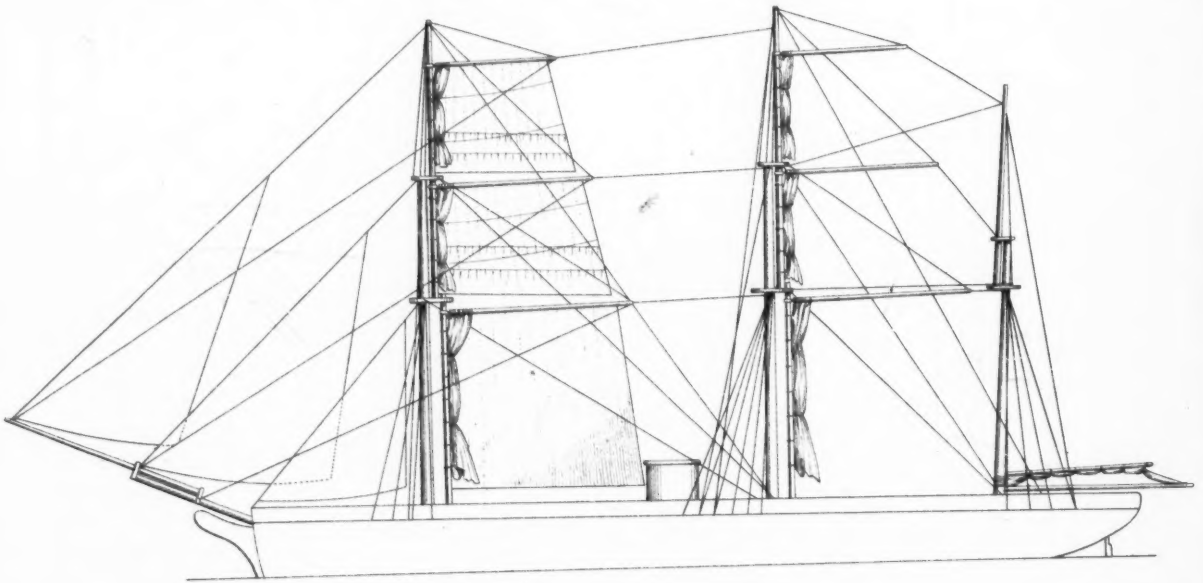
Adopting my previous idea of having a long lower mast head, I place my plain pole topmast on the aft side of the mast. At an increased distance from the mast I place a trysail mast. I am not quite certain if this will be always required, or, indeed, if I am obliged to use a trysail mast at all. On the aft side of the masts I have a series of half-yards connected at their

fore-ends by joints to the trysail masts, except the two upper ones, which are connected to a parral to work up and down upon the topmast. To these half-yards I propose to bend ordinary square sails provided with trysing-to jackstays up and down the centre, and also brails or leech-lines on each side leading in amidships. The sails will be bent to the half-yards by rings or sliding metal toggles. I place the after-shroud of my rigging abreast of the mast, or a little before it, and the after-swifter I take considerably far aft between the half-yards, and in fact they could be more properly denominated backstays. The topmast rigging is arranged in the same manner, and for the same objects. The ends of the half-yards are supported by lifts, and are also provided with braces aft and forward. With the help of the diagrams, I trust my description will be intelligible. By this arrangement it will be seen that when the sails are not in use they are brailed up close to the masts, and the half-yards are allowed to come fore-and-aft. When the fore-and-aft sails are required, one-half of the sails are hauled out, forming an admirable system of trysails; when square sails are required, the other half of the sails are hauled out, and the half-yards allowed to extend; the action of the yards and swinging booms being to stick out the sails clear of the rigging. The arrangement of the rigging before described allows the half-yards to be braced considerably forward, and the square sails used within a point or two of what they would be on the old plan. On the wind heading, by letting go the foremast or preventer-braces, the half-yards instantly fly aft, and the sail can be brailed up with the greatest ease.

Plate 5.—On the foremast in this figure, the lee halves of the sails are exhibited set, the weather halves being brailed up. On the mainmast the lee halves are also brailed up, and the sails entirely taken in. The ship in this case is supposed to be steaming head to wind, or at anchor. Diagram 6 exhibits the ship running free with the two sides or halves of the sails set, or rather the whole of the sails set. As the sails are represented in the drawing, the wind is supposed to be a little before the beam. When the whole sail is set, the trysing-to jack-stays are let go; and the effect of the two topsail sheets being hauled out with the two half-yards not in a line with each other, but forming an obtuse angle say of 160°, is to stick the sails aft, considerably away from the masts and rigging; and it is this result which enables the sails to be used as *square* sails with the wind well forward, without impediment from the rigging. This important feature in the plan was found out during my practical experiments, and at once removed a difficulty which, when I at first went into the matter, appeared to be a formidable obstacle.

In my earliest design I adopted two separate sails, or rather I may denominate them duplicate trysails; but the confinement of the fore-leech of the sail to the mast would only permit the expanded sails to be used with the wind right aft, or at a very small angle with the keel. The power, therefore, of using the sails for running off the wind or with the wind free, was so limited, that I considered it inexpedient to pursue the subject in that form. The employment, however, of entire square sails, instead of separate trysails, so extended the capabilities of the design, that I do not hesitate in bringing it before the public with the fullest belief in its practical value. The only example which I have here given of a ship

Mr. CUNNINGHAM'S IMPROVED RIG FOR STEAM SHIPS.



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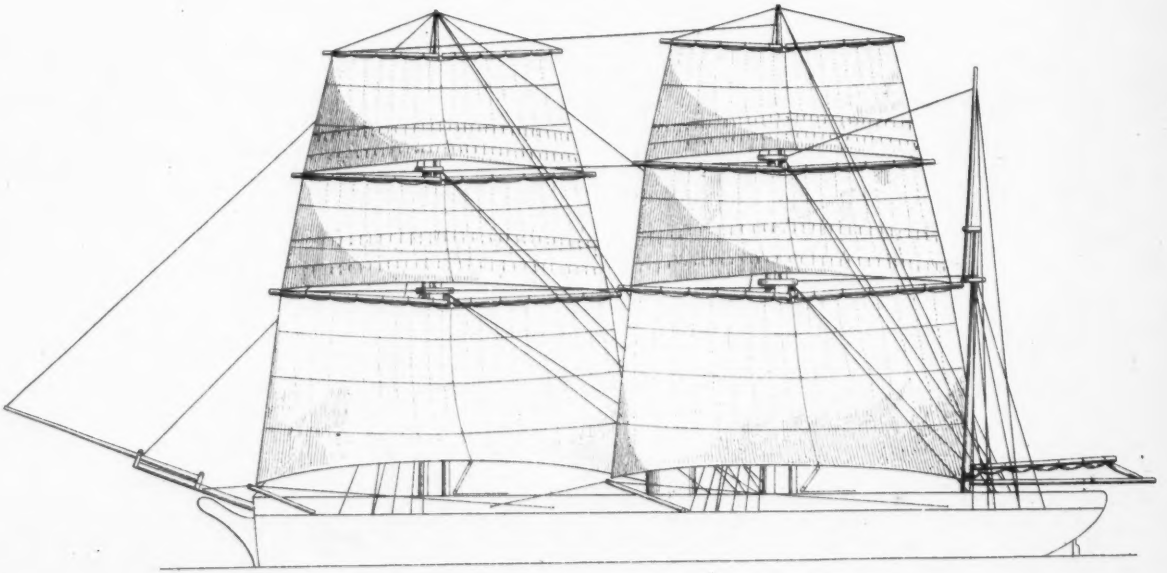
Mr CUNNINGHAM'S IMPROVED RIG FOR STEAM SHIPS.



J.R.Johbins.

rigged on my new plan, represents a ship of large size, but for smaller vessels a much more simple arrangement might be made; for instance, the lower mast-head might be of the ordinary length, and one topsail only applied instead of two. I would still have the topmast placed abaft the lower mast, as it brings the topsail in a more favourable position with reference to the sail below and the rigging. I believe, too, that the trysail masts may be dispensed with.

By the experiments which I have made on a small scale, I have been very much struck with the energy of action which the square sails thus arranged appeared to possess. It will be seen, that by the way, the foot of the sail is stuck out, the plane of the sail remains at a favourable position to receive the full energetic effect of the impingement of the wind upon it. The plane of an ordinary sail, when its foot yields to the pressure of the wind, assumes such an angle that the tendency of the wind is to glance off it, and thus much of its energy is lost. In other ways, too, the experiments were singularly satisfactory, and have quite satisfied me that the rig which I now propose is more consistent with the requirements of steamships than the arrangement of cumbrous yards and profusion of rigging, as now existing.

THE RIGGING OF LARGE SCREW VESSELS.

By Commander W. Horton, R.N.

I am not only very fortunate in having to follow on such an interesting paper, leading up to the point from which I purpose to take my departure; but it is the more gratifying to have been preceded by Mr. Cunningham (for holding communication with whom our meeting in this room to-day afforded the first opportunity in my life), because I find so great identity of opinion held by us upon many points of our common subject.

The subject itself, on the other hand, although of great importance and of professional interest, is one which admits of but little illustration or enlivenment for those who may not be professionally interested in it.

I shall, therefore, be as brief as possible, and shall no doubt be pardoned the omission of figures or calculations. After having explained the diagrams, and offered the observations which I have prepared, I shall be happy to give answer, as well as I am able, to any inquiries or objections that may be made; my object being not to dogmatise or to offer instruction to those who might perhaps be able to instruct me on ground so purely technical, but to promote the discussion of a subject which I deem to deserve more attention that it would appear to receive. Neither is it my intention to criticise or to comment upon the work of my professional superiors beyond what may be necessary for the illustration or explanation of my own views.

On referring to one of the plates in Charnock's "History of Naval Architecture," representing H.M. ship the "Prince Royal," A.D. 1610,

I find very nearly the same position of masts which it has been found expedient to maintain down to the present day in the few remaining sailing-ships, of which the "Ganges," recently paid off, was perhaps the last that we shall ever see belonging to the Navy of this country.

But within the last ten years the application of the screw has produced a class of frigates just double the length of their predecessors; and the question very naturally suggests itself, in observing the great length of the "Orlando" or "Black Prince," whether advantage might not be taken of their increased length, to apply to them some form of rig composed of portions more handy than those now in use.

We have, in fact, attained a practical limit to the height of masts and to the space between them, as well as to the dimensions of spars and sails; and it has even been found expedient to recede in some degree from the dimensions which had been given to the lower yards of our largest class of screw-ships.

The length of ships, on the other hand, continued to increase until the "Great Eastern" had attained the length of a furlong, one-eighth of a statute mile, within a few feet either way.

Again, taking a rapid review of the gradual development of ships and their sailing equipment, from the earliest times, we may still find their various forms and sizes represented in the vessels with which we are familiar on our own coasts.

Here we have the lug-sail boat, the cutter, the schooner and the brig, the barque and the full-rigged ship, each marking so many stages in the growth of ships and in the consequent complexity of their rig.

When the size of the vessel became such as to exceed the proportions convenient and safe for a single mast, a bowsprit was projected, then a second mast was added, and a third, which last form of rig has been found so convenient in all respects, that its various parts have been gradually increased in proportion to the progressive growth of ships during the last 300 years, until the present generation has seen the spars and sails attain dimensions inconvenient in the handling, and insecure as regards the materials employed.

I shall endeavour to describe the alterations which I have to propose for discussion, in the hope that, from a fair and impartial consideration of the advantages and disadvantages in the present or the proposed plan, some result may arise which shall awaken fresh attention to the subject on the part of those who have power or influence to introduce novelties where they must of necessity be very cautiously received.

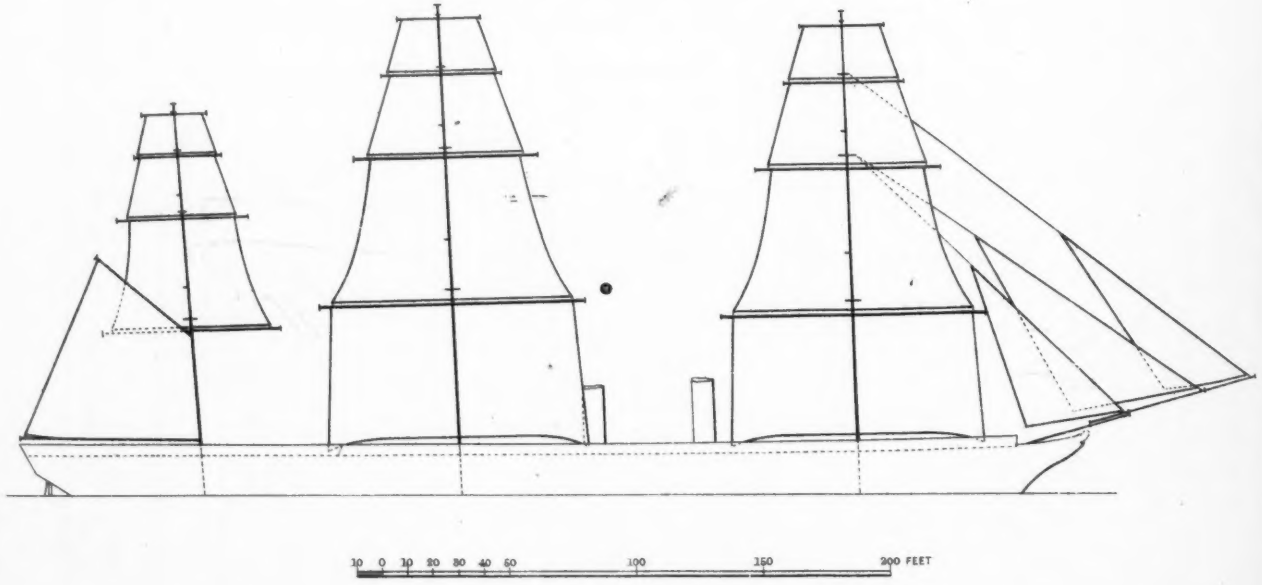
In order to test the merits of three masts as being of unlimited application, let us consider the extreme case of the "Great Eastern."

Would any man have thought of erecting only three masts on a ship of her great length? The very idea of such a thing appears absurd, and the mind is at once reconciled to the idea of her five or six or any other number of masts, as well as to the total absence of bowsprit.

The next less class of ship is that of which the "Warrior" is the type, and in her case we make a sudden return to three masts.

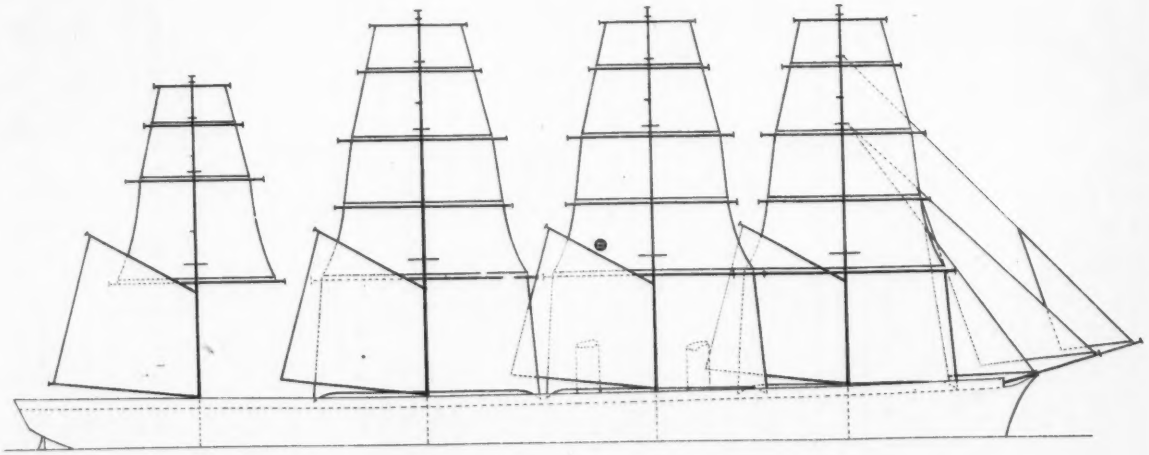
Plate I. represents the "Warrior" as she is, accurately reduced from an official document. There, then, we see this mail-clad "Warrior"—this Goliath among ships—wearing the outer garments of the stripling

SAILS OF H.M.S. WARRIOR.



J.R. Jobbins.

SAILS PROPOSED FOR H.M.S. WARRIOR.



10 0 10 20 30 40 60 100 150 200 FEET

J.R. Johbins

David. The eye at once detects the disproportion, and she presents much the same appearance that a footman six feet high would do, dressed in the livery of a four-foot boy. The "Warrior" and the 80-gun ships measure respectively on the water-line 380 and 230 feet, or as about 9½ to 6; while their displacement differs in the proportion of nearly 4 to 3—that of the Warrior being 8,625 tons, while that of the ship whose sails she bears is 5,996.

And if we consider that these quantities of water have to be removed each time the ships advance their own length, it is clear that the same sails and same force of wind can only be expected to propel the "Warrior" at a fraction of the speed which they would impart to the 80-gun ship. Great expectations have been formed of the speed of the "Warrior," when free from weeds, on account of the fineness of her form; but it would be an unheard-of success in naval architecture which should place two ships so dissimilar in all other respects upon an equality of speed with the same propelling power. Else why not give the same engines and boilers to both ships? It cannot, therefore, be contemplated that the "Warrior" should be a fast-sailing ship under canvas only, in moderate weather. Advantage ought, then, to be taken of her great size, to make her a fast ship under circumstances which would compel other ships to take care of themselves under low sail.

Some good reason has doubtless caused the amount of her area of sail-surface to be fixed at what it is—namely, somewhat under 34,000 square feet. Sir Baldwin Walker was anxious, if possible, to give the "Warrior" four or five iron masts, as he himself told me when she was first designed; but difficulties arose on account of the position in which the engines and boilers were required to be placed, and the idea was abandoned in favour of the rig here displayed. But I learn from the constructor, Mr. Watts, that no insuperable difficulty stands in the way of erecting an iron mast over the machinery, as regards *structure;* though it is but fair to add that that gentleman saw reasons of another nature which appeared to him to make it undesirable to do so. The problem, then, as regards the "Warrior," appears to be to distribute the given amount of canvas upon her so as not to interfere with her condition as a powerful steamer, while keeping in view the various requisites for rendering her an efficient ship for cruising under sail alone.

Now, we can hardly consider the "Warrior's" future services as limited to the waters of our own coasts, since the second class of iron-clad ships is constructed expressly for Channel service and coast defence.

I believe, on the contrary, that, if the "Warrior" should realize the anticipations which have been formed of her, we shall find her class of ships employed on service in distant seas, for the protection of our most valuable lines of commerce in other quarters of the globe.

Keeping that prospect in view, I have given much consideration to the form of rig which would appear most suitable to so large and powerful a ship, whose full power of steam is likely to be exerted but on rare occasions; and I now beg leave to offer the plan to your notice, and will proceed shortly to describe it. But I will first state the comparative dimensions of the three classes of ship here represented, beginning with the "Warrior," 380 feet long on the water-line and displacing 8,625

tons. The next is the "Mersey,"* 300 feet long on the water-line, and displacing 5,462 tons. Their respective area of sails, with three masts, is about 33,600 and 26,600 square feet. Their displacement stands, therefore, as 43·1 to 27·3, and their area of canvas as 33·6 to 26·6, relatively.

Plate V. represents approximately the "Defence" or "Resistance," whose length on the water-line is 280 feet, and their displacement about 400 tons greater than that of the "Mersey." The sails I have drawn in Plates II. IV. and V. are those which I shall presently describe.

First, let us turn to those which I propose for the "Warrior," as here placed before you.

The area of sail-surface, exclusive of the gaff-sails, exceeds that assigned to her by the Admiralty to the extent of only about 150 square yards, or 1,350 square feet; while the centre of effort is brought into almost the identical position assigned by her constructor. There is an increased preponderance of turning power at the fore end, which agrees to the requirements in that respect stated of almost all the ships composing the Channel Fleet. The desired conditions are, therefore, pretty accurately fulfilled; while every principal spar is smaller, cheaper, and more handy, and each sail is smaller, stronger, and less liable to accident, the cordage being also shorter, lighter, and stronger in proportion.

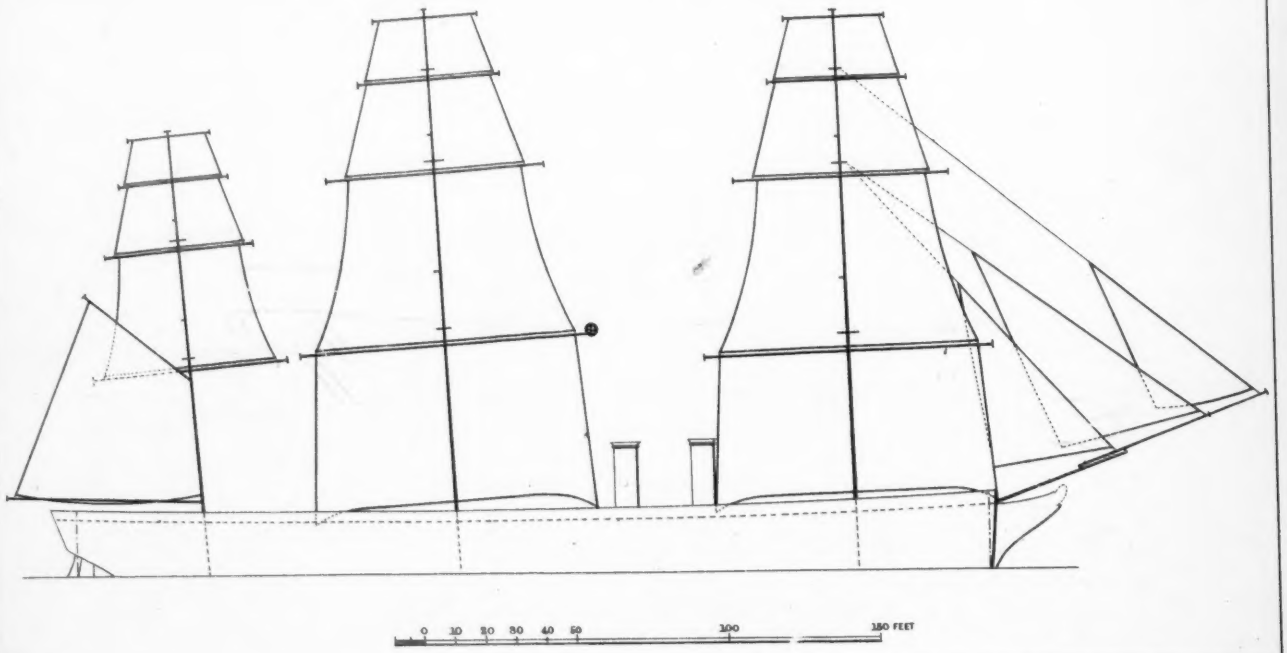
These, at least, are no inconsiderable advantages; and when I state that the weather forebrace of the "Warrior," as now rigged, will exceed the length of the ship herself in the two parts between the head of the mainmast and the fore yard-arm—will measure, in short, nearly 400 feet, while her maintopmast stay will be 172 feet long if taken to the usual place, and 200 where now secured—it is not easy to imagine the strain required to maintain such ropes efficiently taut, nor difficult to perceive that some change is desirable in that respect. Much other inconvenience and very great additional labour must always result from the great distance which separates the masts, and some peculiar arrangements will have to be made to enable the "Warrior" to hoist her launches in or out. At the same time, the turning power obtained by the extended position of the masts is indispensable in so long a ship, especially as the moderate speed she is likely to attain with the sails of a ship two-thirds her own size will scarcely render her a handy ship in stays. The position of the masts which I propose would, however, admit of easy addition to her spread of canvas if found desirable, as well as of any needful change in the balance of canvas upon her two extremities; while the powerful gaff-sails I have here drawn, and the great spread of fore-and-aft canvas which might be introduced in the form of staysails, would prove most valuable auxiliaries and economizers when employing steam and sails combined.

While endeavouring to retain the centre of effort prescribed by the constructor of the "Warrior," I have, in distributing the allotted amount of canvas over four masts, instead of three, placed the masts as I shall presently describe.

I first studied the requirements of the "Mersey" as found to be the result of her trials under sail. I endeavoured to ask for the least number of changes compatible with the alteration of rig which I proposed; and

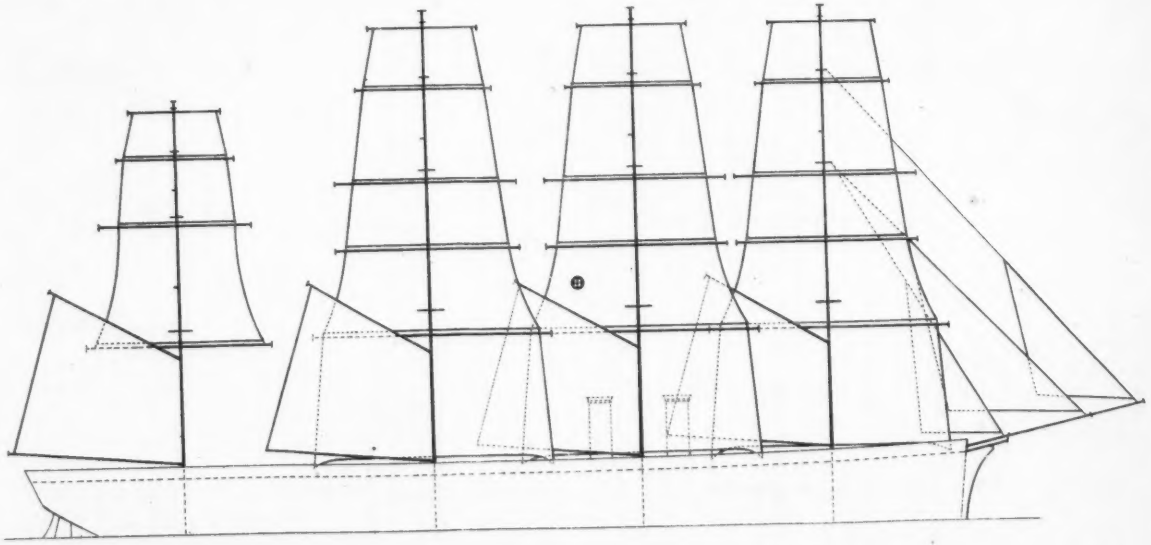
* Plates III. and IV.

SAILS OF H.M.S. MERSEY.



J.R. Jobbins

SAILS PROPOSED FOR H.M.S. MERSEY.



0 10 20 30 40 50 100 150 FEET

J.R.Jobbins

retaining the existing position of her three present masts, I so arranged the canvas that the new mast might step in the stoke-hole, midway, or nearly so, between the funnels.

As in the "Warrior," however, there is a margin of seven feet as to the position of the mainmast, without interfering with the other existing arrangements, I have here shown the "Warrior's" mainmast where I propose to place it—namely, 7 feet abaft its present position. The mizen-mast and "bowmast" would occupy the position of the present mizen-mast and foremast respectively, while I should propose that, all the available space being interposed between the funnels, they might then stand about 50 feet apart, with the new foremast just midway between them.*

This I propose as a starting-point; but, if calculation should determine some other position to be more desirable for the foremast, it would be valuable in any part of the stoke-hole as a ready and powerful means of ventilation, being an iron tube of great length and diameter.

I might here enlarge upon the very great advantages offered by the construction of iron masts and lower and topsail yards for these large ships, as long since proved and established in practice among many of the finest sailing clippers and steam-packets belonging to the ports of Liverpool and Southampton; but I am informed that they are about to be adopted in the "Defence" and "Resistance;" and, when once the first step shall have been taken, I feel confident they will so recommend themselves for their durability, strength, economy, and superior resistance to shot and shell, that their general adoption throughout Her Majesty's fleet cannot be long deferred.

With respect to the rig, however, which I was describing as my proposal for the "Warrior" class, I have there endeavoured, by way of compensation for the increased number of the spars and sails, to have as many of them alike as possible; and in this attempt I have succeeded as far as follows:—

The three lower yards are exactly alike, being each 18 feet shorter than those of the 80-gun ship, and they are at the same height above the water as the crossjack yard, whose dimensions, with those of the sails above it, remain almost exactly as before. The six topsail yards on the bow, fore, and main masts are exactly like the crossjack yard, and all the other spars and sails on those three masts exactly correspond.

* Of course a change in the position of the foremast, to place it conveniently with respect to the funnels, would affect the centre of effort of the sails. But, as the memory of most officers would recall many and considerable alterations made in the position of masts adopted by those whose only guide should be science, it would ill become me to predict the sailing qualities of the "Warrior" with reference to the position of her masts; but a ship rigged with four masts would admit of more simple and less expensive alteration in the effect of her sails, in accordance with the dictates of experiment, than is the case when rigged with three masts. *E.g.* if in the present instance too great a preponderance of sail were applied to the fore body of the ship, the introduction of a crossjack course, followed by the removal of the flying jib, and then doing away with the bow and mizen royals, would all be means available for effecting the needful change in a moderate degree, while a slight increase in the spread of yards on either of the masts of the after body would produce a still greater effect without requiring any alteration in the position of the masts; whereas, in a ship with three masts, the yards have already attained their full development, and recourse must be had to more serious alterations in order to affect the balance of canvas on the ship.

I propose that the mizen and three upper topsails of the other masts should be on Mr. Cunningham's plan—an application of that ingenious system which has already had successful trial, and is due, I believe, to Captain Schomberg, and which, I am informed, is adopted for the "Resistance" and "Defence." The lower masts would be of iron, like the lower and topsail yards, and would be of very great diameter, to withstand the effects of shot and shell. Being considerably shorter than at present from the deck to the eyes of the rigging, they would be also much better supported, while the courses of so greatly reduced dimensions would require no reefs; and the lower topsails, set above a long mast-head, would be of very great value under every variety of circumstances.

This last point has been established by long trial, and by their very general adoption in the finest merchant ships of both this country and the United States, though stedfastly opposed for thirty years in the Royal Navy since their first introduction to notice in 1830 or 1831, by Lieutenant Goldsmith, then of H.M.S. "Revenge." I am not aware that any more rational objection than that of prejudice so long prevailed against the double topsails; but it is to be hoped that the trial about to be made of them in the "Defence" and "Resistance" will cause that prejudice to be set aside, and so excellent a contrivance to be definitively adopted.

Another matter in which the mercantile marine has been in advance of the Royal Navy, is the reduction of that useless and, to my mind, unsightly addition to the beautifully formed bows of our modern ships, which still continues to be known under the remarkable name of "head-knee." Once upon a time it had its use in affording support to the bowsprit, when the bowsprit was made to support the foremast; but, with the lengthened bows of ships now able to support not the foremast only, but also the foretopmast, this massive structure, called a head-knee, is about as useful as a knee-joint would be in the human head.

It is generally abolished, or very much reduced in weight, among our finest merchant ships; and I am informed that it is now made less heavy in the Royal dockyards, but that still that portion of the "Marlborough" weighs about 17½ tons; that of the "Donegal," 12½; in frigates, about 10 tons; and in smaller wooden ships in proportion; while I have it on the best authority that in the "Warrior" it weighs 15 tons, though it bears the appearance of very much more.

I cannot admire the device by which those 15 tons of useless iron were to be so affixed to the "Warrior's" bows, that in case of a collision she was to part with the excrescence, as a lobster has power to shed its claws in case of need, of course breaking very much the force of the blow. There is this great difference, however, that nature produces from her abundant stores a new claw for the lobster free of charge, while for the "Warrior's" new head-piece another kind of provision is made, by the Navy Estimates and Income Tax.

Taking the case of a frigate like the "Mersey," the weight of extraneous matter is about equal to that of Horsfall's great gun hung over the bows; and when we add to this 11 or 12 tons for the weight of the bowsprit, and between 2 and 3 tons for the other outside spars, besides all the weight of the gear and sails, and multiply the sum total into the length of the lever at whose end it is applied, it is almost marvellous that so great strength

should be thrown into the structure of a ship's bows as to resist the strain brought upon them when pitching in a heavy sea.

I propose that in this altered plan there should be no bowsprit, but a sufficient projection of head-knee, of only the requisite substance, to give support to the jib and flying jib-booms, and to receive the foretopmast stays. The jib-boom in its turn is only of sufficient dimensions to give support to the fore top-gallant mast, and the head-sails are made small in proportion.

They represent one-fifth of the total horizontal moment of the sails as measured from the sternpost, while in the "Warrior" and "Mersey," rigged with three masts, their moment may be stated at about one-third of the whole.

The difference is amply compensated by the introduction of the fourth mast in the fore-body of the ship; and, if the relative weight be called in question, the moment of a given weight, at the distance of this foremast from the centre of gravity of the ship, will be about as one to five and a half, when compared with the same weight applied at the bow.

I am aware that a strong feeling exists in favour of jibs as a turning power; but I am free to confess my own prejudice *against* them as applied to very long ships.

I have stated the relative proportion of effort produced by the combined head-sails in each of these two cases as one-third and one-fifth of the whole. Let me suggest once more an extreme case, and ask you to consider what would be the value of a jib projected a few feet beyond the bows of the "Great Eastern." I apprehend it would scarcely be appreciably greater than that of her present fore-staysail. The jib is, moreover, an unmanageable sail as compared with square sails when "boxing off," while it cannot fail of pressing the bows of a ship in the water. I have lately heard a remarkable instance of a beautiful new corvette, the "Rinaldo," which has required twenty tons of iron ballast placed in her run to counteract the weights which brought down her bows several inches below the estimated trim. Who would not command such a vessel, denuded of her cutwater, and with a different distribution of her weights in the fore-body, rather than carrying twenty tons of iron ballast in her run? By way of contrast, the "Immortalité," the fastest vessel ever known in the Navy, retains her foremast considerably further from the bow than any other ship in the service.

One other point remains to be mentioned, which is the abolition of studding-sails. Any person may, by a simple diagram, lead his mind towards a conclusion as to their real value. My own feeling is, that in a steamer they *may be* of occasional use on five points of the wind, and *must be* of decided hindrance on the remaining twenty-seven. Were the ship to be viewed as a *sailing-ship* only, I think they ought to be supplied for one mast only, and used occasionally for the sake of practice. But in the case of the "Warrior," if supplied to her for running down the trade winds, they ought to be carefully secured against rats and mildew at all other times, and the booms and gear only sent aloft when required for use.

In the recent commission of H.M.S. "Marlborough" as flag-ship in the Mediterranean, "the booms and irons were removed from her main-yard

and found to weigh twenty-one and a half hundredweight. The studding-sails, blocks, gear, and yards weighed nineteen hundredweight more; thus two tons of top-hamper were removed. * * * The 'Marlborough's' studding-sails contained 3,500 yards of canvas, as many fathoms of rope, many blocks, &c. the whole not weighing less than six or seven tons, and I don't think the vessel went an additional hundred miles by them in the commission."

These are the words of one of the principal officers of the ship, who served the whole commission in her, and who is a seaman of great skill and experience.

When we further consider the prime cost, deterioration, repairs, decay, risk of life, constant labour, and vexation of spirit attendant on studding-sails throughout Her Majesty's Fleet, now provided with steam-power for chasing an enemy or other emergent service, and that those ships are, generally speaking, fast sailers off the wind, requiring proportionably a far greater increase of canvas than formerly, to add to their speed in the same degree as in our sailing-ships of old, I do not hesitate to express a decided opinion that studding-sails ought to be abolished throughout the service, except on one mast, which, I think, should be the mainmast.*

The operation of hoisting large boats in and out is a most important one in ships of war, occurring so frequently, and under every variety of circumstance. It is, therefore, one to which every facility should be afforded.

In the long frigates, such as the "Diadem" and "Mersey," although their yards, when square, extend well beyond the side of the ship, the great space between the masts requires that the yards should be so much braced in for this operation that the boats will scarcely clear the side, and, as a matter of course, great strain is brought upon all the materials so employed.

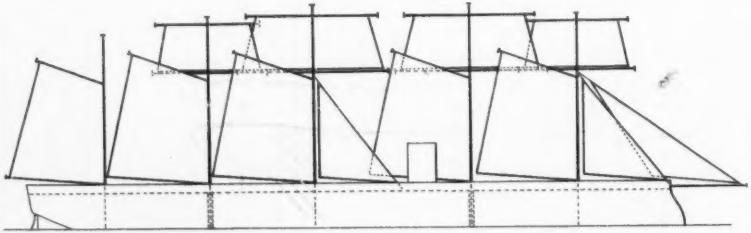
In the "Warrior," therefore, whose foremast and mainmast are 160 feet apart, and whose yard-arms will be about 100 feet asunder when hoisting in her 42-feet launches, it is clear that some peculiar arrangement will have to be made.

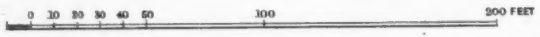
But either of these ships, if rigged with four masts, and with much shorter and stouter lower yards and long mastheads, could keep their yards square, and employ all six yard-arms at the same time if necessary.

* Let a represent the area of sails which would propel an old ship of the line eight knots an hour, with a breeze of force five or six, when sailing free, and let $a+36$ be the proportion required to increase her speed to ten knots; for $8 \times 8 = 64$, and $10 \times 10 = 100$, and $100 - 64 = 36$. Again, let a represent the same area of sails applied to a ship capable of sailing ten knots an hour with the same wind, when going free. Then $a + 44$ would be the proportion requisite to increase the speed of the ship two knots an hour; for $10 \times 10 = 100$, and $12 \times 12 = 144$. Therefore $44 - 36 = 8$, shows an increase of rather more than one-fourth in the area of studding-sails due to the second case in excess of the first, besides some consideration due to the increased speed of sailing away from the wind, whose rate of progress would be only about twenty-five miles an hour, and the ship's increased rate of departure from it, in the second case more than in the first, would be nearly as 15 to 13. Indeed, I find in Creuze's work on Naval Architecture quotations from a scientific author whom he names as Don Juan, to the effect that ships do on certain points of sailing attain to the same velocity as the wind which propels them; and in common practice, off the wind, do acquire a large proportion of the wind's velocity. This would add force to my own calculations as stated above.

Pl. V.

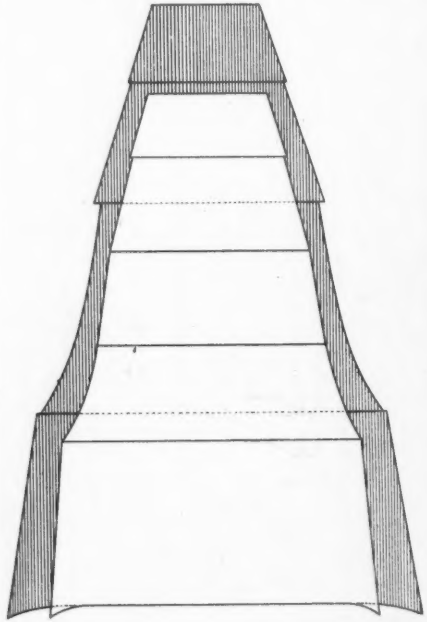
RIG. PROPOSED FOR H.M.S. DEFENCE.





Pl. VI.

Comparative area of Sails on Warriors Mainmast in Plates I & II.



J.R Jobbins

Finally, I would recommend that, all masts being stepped upright, the top-gallant masts of all steamers should be fidded abaft the topmast. They could then be housed on all occasions of steaming, and, with their heels resting on the lower-mast head, a short mast-rope and burton would answer for all such occasions in nine cases out of ten.

The eye becomes quickly reconciled to all changes which are not opposed to reason; and, whether in the matter of overhanging figure-heads and bowsprits, raking sterns, or raking masts and funnels, there is no sufficient reason to justify their continuance in these days, when the serviceable state of the Fleet requires more than ever to be considered in the first place.

With regard to the "Mersey," I have few words to add to the statement that the distribution of her canvas is made in accordance with the principles explained in the case of the "Warrior;" or, rather, I should say, having had the advantage of learning from her captain what he considers to be desirable in the way of alteration in the "Mersey's" rig, I have endeavoured, in my own way, to meet those requirements, and have subsequently applied the same principles to the yet untried "Warrior." The "Mersey," however, would require a short stout iron bowsprit.

The third and last class of ships of which I desire to speak is that which is here approximately represented as the "Resistance" or "Defence." They are 20 feet shorter than the "Mersey" on the water-line, and their displacement 400 tons greater than hers.

Their displacement is, in fact, almost identical with that of the 80-gun ship whose sails are now applied to the "Warrior"—that of the new ships being 5,853, and that of the 80-gun ship 5,996. I am informed that these ships will be rigged as barks, with iron masts, iron lower and topsail yards, duplex topsails, and Mr. Cunningham's reef applied to the upper ones. They seem to bear considerable resemblance to "La Gloire," though not so entirely protected. But, while it is wise to borrow all ideas of improved naval construction from our ingenious neighbours and chief naval rivals, there is also wisdom in abstaining from the imitation of so preposterous a rig, when applied to a ship nearly the length of the "Mersey," as that which we remember in the early days of paddle-steamers, such as the "Dee," "Rhadamanthus," and "Phœnix," and which is now adopted in "La Gloire."

The rig which I propose for them is as follows, and is borrowed in idea from a sketch by Capt. Cowper Coles of a rig equally suitable for his iron-cased ships, which I hope we may in due time see fitted with it, and cruising under it for the protection of our coasts if necessity should so require. I have, however, so modified Capt. Coles's drawing as to apply it to the precise dimensions and fittings of the "Defence" and "Resistance," as now constructed. Retaining the present position of the fore and main masts, and removing the mizen-mast, I think, 5 feet further aft, I would make use of two existing empty spaces of 2 feet each, fore and aft, between double bulkheads, which form part of the defensive structure of the ships, to introduce two other masts, completing the number to five. The masts should be made of iron, strong, tapered, of large diameter, and standing perpendicular to the water. They would have gaff-sails all

alike—except the mizen, somewhat smaller—with booms where practicable, and hoops at head and foot, which I know by experience to be a method most convenient for setting large fore-and-aft sails in a steamer. There would be a fore staysail and a main staysail exactly similar, and, if found desirable, a running bowsprit and a sloop's jib.

On the tapered mast-heads, would be topsails on Mr. Cunningham's plan, the lower yards having iron parrels to work above the eyes of the lower rigging. Two of the lower yards would be squarer than the other two, and the topsails above them larger in proportion. These topsails would be used chiefly when sailing free. Such vessels would be employed always under steam, when great economy would be practicable by the use of the fore-and-aft sails, while these would be manageable by means of such crews as are now being trained to the use of guns and arms, though not likely to prove the most practised seamen for square-rigged vessels.

At the same time, comparatively little obstruction would arise out of the rig of these ships when steaming against the wind; for it is to be remembered, in taking leave of the subject, how rapidly the resistance of steamers' masts increases in proportion to the increase of their height.*

THE CHAIRMAN.—The Institution is much indebted to Mr. Cunningham and Captain Horton for their very interesting and suggestive papers. The masting, &c. of vessels of war of very great length, is a subject which I believe is now engaging a good deal of attention. That the ordinary equipment of masts and sails should, with but slight modifications, have maintained its ground among all maritime nations for so many generations, is a proof of its admirable adaptation to the purposes for which it was designed; but it seems not improbable that considerable changes will follow the general use of the screw propeller, and the immensely increased length of modern ships. Manageability of sails and gear, increased facility of turning, by throwing a greater effective sail-force before or abaft the centre of gravity than is practicable with three masts, and other considerations, appear to render an addition to the number of masts desirable. Engines and the funnels present obstacles to the greater division of the area of canvas; but, if the need be found urgent, such difficulties will no doubt be overcome. Mr. Cunningham has been so successful hitherto in his practical efforts to improve the sail equipment of vessels, that I am inclined to attach considerable weight to any further proposition from him on this subject, not excepting certain points of the ingenious scheme shown by the model before us, which at first sight may seem open to some objections.

MR. CUNNINGHAM, in reply to various questions by the Chairman and other gentlemen, observed that in the event of being taken aback with the sails set as square-sails, by letting go the foremast braces the haulyards and sail attached would instantly fly aft and remove the head pressure on the sails; indeed, he considered that his plan offered advantages over the ordinary arrange-

* Since the foregoing was sent to press I have learned that the fore-mast and mizen-mast of the "Defence" have been moved some feet away from the extremities in adopting the improved rig for that ship. The above description, and the drawing shown in Plate V., must not therefore be understood as applying to the present positions of these masts, but to those which they would have occupied in the form of rig which it was originally in contemplation to give to that ship. W. H.

ment of yards in this respect. There was no question, too, that these important advantages existed, viz. that the sail could be entirely taken in and set from the deck without sending men aloft, and that too most expeditiously. He considered that a very important consideration in the rig of a screw steam ship-of-war was to provide the means of quickly disengaging the wreckage alongside in the event of losing a mast in action, as the entanglement of the rigging in the screw would be a casualty to be anxiously guarded against, and that his plan of rig was favourable for carrying out this object. He would propose fitting his topmast rigging over a funnel, which would slip off the topmast easily in case of need; he would have iron lower masts, iron tubes for the half-yards, and as much iron wire rope and chain in the rigging as possible, so that in the event of the mast being shot away the wreckage should not float, but rapidly sink. The tube half-yards should have openings at the ends to allow them to fill with water. The square sails set on his plan would stand with the wind about two points before the beam; and when no longer useful the weather half would be brailed up, and the lee halves act as admirable trysails. In the trials which he had made on a small scale in Portsmouth Harbour, he imagined that he observed a singular amount of energy in the action of the sail, resulting, he believed, from the plane of the sail being at a more favourable angle to sustain the pressure of the wind upon it than sails on the ordinary plan.

Mr. LACON.—How do you reef the sails on each side?

Mr. CUNNINGHAM.—I propose to fit the two upper half-yards to a parrall, which would slide up and down the topmast, carrying with it of course the two half-yards and sail attached to them. The upper topsail I would fit with reef points, and cranks to reef by the foot The operation of reefing would be to brail up the sail and settle the haulyards, supporting the parrall, and also the lifts, until the sail was sufficiently low to sheet out home, the sheet would then be hooked to the reef cringle, and, the points being tied, the sail would be hauled out.

MR. LACON.—Do you do away with the old plan?

Mr. CUNNINGHAM.—My arrangement may be viewed as an opponent to the old plan; inasmuch as it provides an entirely new arrangement for setting the sails, or, in other words, applying the sail-power. With reference to a remark from Commander Horton, Mr. Cunningham further observed that, upon this arragement of the long mast-head and half-yards, a very powerful system of staysails was also provided.

Commander HORTON.—Would the half-yards be as available as the ordinary yards for hoisting boats in and out?

Mr. CUNNINGHAM.—Quite so. You can brace them independently of each other aft or forward.

Commander HORTON.—With reference to iron masts, it may be observed that the greater the bulk of a wooden mast the greater its power of flotation, which is a great objection, owing to the chance of it, or its gear, fouling the screw; whereas any increase in size of the *iron* mast must hasten its sinking out of the way. I believe objections to iron masts are less common than formerly. In the case of the "Resistance" and "Defence," designs were sent out by Sir B. Walker, and iron masts were proposed which would have been of the same weight as wooden ones. I am informed by an eminent ship-builder that, when difficulty arises in the

stepping of an additional mast in the ordinary way, there is often no hindrance to its being placed over the machinery. Mr. Roberts, C.E. has a very convenient mode of constructing iron masts, which would be applicable under most circumstances.

Mr. LACON.—Has your scheme, Mr. Cunningham, been long before the public?

Mr. CUNNINGHAM.—This is the first time it has been publicly exhibited.